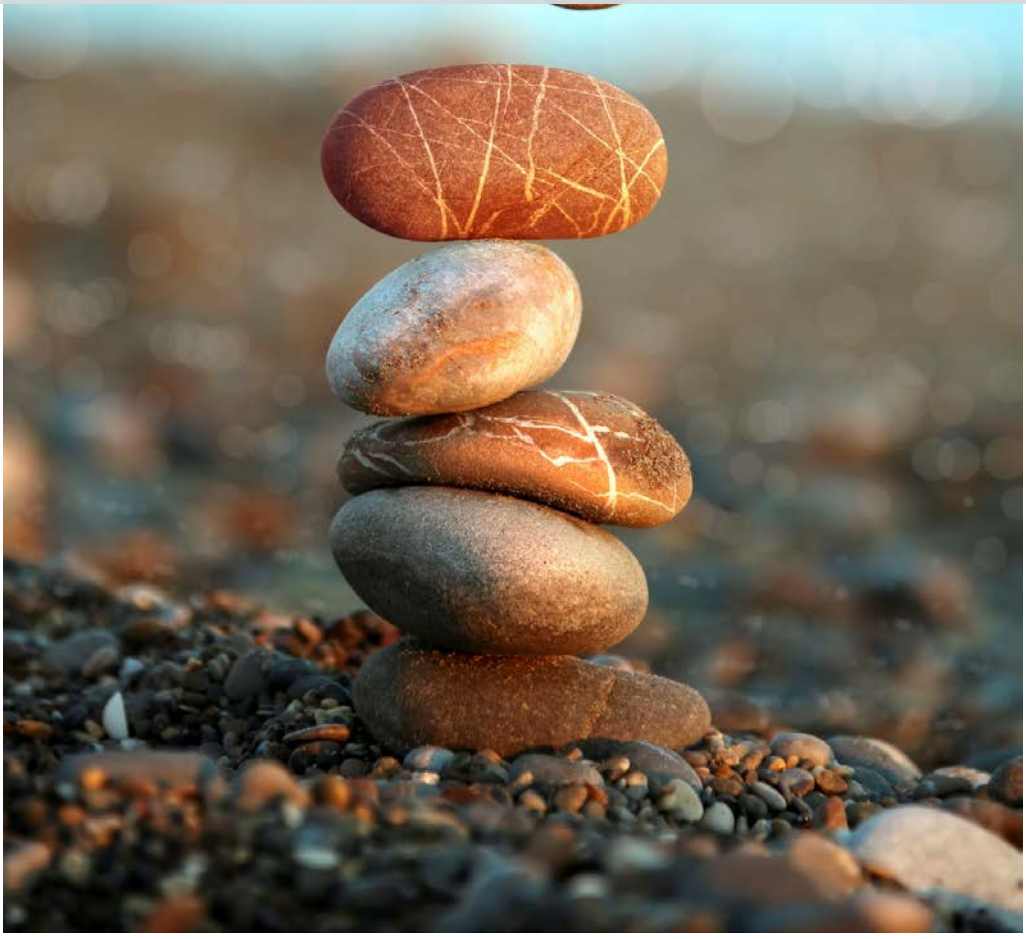
ALLEN+CLARKE

REVIEW OF PHYSICAL ACTIVITY GUIDANCE AND RESOURCES FOR UNDER FIVES

Final report for the Ministry of Health

December 2015



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Disclaimer - The Ministry of Health commissioned and funded Allen and Clarke to complete a scoping project on physical activity resources and guidance for under-fives. *The Review of Physical Activity Guidance and Resources for Under-Fives* report forms part of the scoping project and has been accepted as advice to the Ministry of Health. Options within the report will be used by the Ministry to inform policy development but not necessarily be adopted as Ministry policy.

KEY TERMS

This report uses the following terms and acronyms.

Abbreviation/ initialism	Description
%BF	Percent body fat
BMI	Body mass index
es	Effect size
FM	Fat mass
FMS	Fundamental movement skills
IOTF	International Obesity Task Force
METs	Metabolic equivalents
MVPA	Moderate-to-vigorous physical activity
OR	Odds ratio
PA	Physical activity
RCT	Randomised controlled trial
RST	Regional Sports Trust
SF	Skinfold thickness
TV	Television

A list of definitions is provided in page 50.

CONTENTS

EXECUTIVE SUMMARY

In light of the recent findings in the draft Ending Childhood Obesity Report (ECHO Report) (WHO 2015), it is timely to review the existing Active Movement resources (which are now ten years old) alongside the evidence base. This will help to determine if an update of the existing Active Movement resources is needed and, if so, what the most appropriate way to update the information is.

The Ministry of Health contracted *Allen + Clarke* to complete a literature review examining the effect of physical activity (PA) and fundamental movement skills (FMS), time spent being sedentary and sleep on a range of health outcomes for children aged under five years (i.e., from birth to four years inclusive). As part of this work, *Allen + Clarke* also reviewed population health advice on PA, sedentary behaviour and sleep from countries similar to New Zealand, and undertook a survey of New Zealand stakeholders' views to determine which FMS resources they use (including the Active Movement resources), how they use them, how the Active Movement resources could be improved and what else they need.

Methodology

This report is informed by three evidence collection approaches: a narrative review of academic research published since 2011, a review of population health advice provided in five comparison countries (Australia, Canada, Ireland, the United Kingdom and the United States of America), and a survey of New Zealand users' views of the Active Movement resources.

The narrative review of academic research built on evidence presented in earlier systematic reviews undertaken by Timmons et al (2012) and Le Blanc et al (2012). *Allen + Clarke* reviewed a total of 28 articles exploring 21 unique studies. The findings presented are generally consistent with those found by Timmons et al and Le Blanc et al's earlier reviews.

A survey of New Zealand-based users' satisfaction with the Active Movement resources was conducted. The survey explored views on the existing Active Movement resources and preferences for new resources (i.e., type, content/required information, access and format). A total of 225 completed survey responses from a wide range of stakeholders (including early childhood educators, regional sports trusts, health practitioners, parents, and others working with children aged under five years) were received.

Key findings from the academic literature review

Findings are based on the best available evidence. The evidence reviewed was not always from large samples or high quality studies. A total of 28 articles covering 21 unique studies were identified. There is considerable consistency between the evidence base explored by *Allen + Clarke* and the evidence base covered by previous systematic reviews undertaken by Timmons et al (2012) and Le Blanc et al (2012).

All three health behaviours - physical activity, sedentary behaviour, and sleep habits - appear to be associated with health outcomes although to varying degrees. Taking a holistic approach by developing national recommendations around all three behaviours could be warranted.

Dose-response relationships for all three health behaviours exist, but evidence on the exact nature of this is limited. Such evidence is crucial in determining how much PA, time spent being sedentary and sleep is necessary to promote healthy growth and development in very young children. While evidence is emerging, it is not sufficiently large enough or varied enough to provide definitive recommendations on the frequency, intensity, duration, type and context of PA, sedentary behaviour and sleep, required to achieve optimal health outcomes - at this time.

Adiposity/obesity was the most frequently examined health outcome. Confidence in the conclusions drawn for adiposity is higher compared with conclusions made for other health outcomes because of the depth of evidence available. In addition to adiposity, all three health behaviours appear to be linked with other health outcomes also but the available research is very limited and varies in quality.

Where associations do exist, the strength of associations or changes seen are typically small. A potential reflection of the many factors that can exert an effect on health outcomes (other than PA, sedentary behaviour and sleep). The strength of the relationships/impacts reported may have been underestimated because of study design limitations; however, small changes at an individual level, if applied population wide, could have large public health benefits.

Interventions targeting increased PA or reduced screen time had low success in changing health outcomes. This lack of impact may be reflective of the studies not being sufficiently powered to detect associations or the intervention not intensive or different enough to exert an effect above usual practice control.

Key findings from the review of population health advice from other countries

Australia, Canada, Ireland, the United Kingdom and the USA provide population health advice on PA for children aged under five years. This advice includes information about the amount and type of activity young children should be doing, where and how often (i.e., information about the type, frequency, duration, intensity and context). Most of the studied countries present advice by age (i.e., advice for infants, toddlers and pre-schoolers). One presents advice by developmental stage (i.e., walking or not walking). Regardless, the advice provided is highly consistent across all countries: all children should participate in unstructured play throughout the day. Toddlers and pre-schoolers are encouraged to use movements that involve all of the main muscle groups and to be physically active for at least three hours per day.

Other countries also generally provide advice on time spent being sedentary for children aged under five years. This advice is usually nested within PA guidelines for very young children or presented as a complementary guideline. As with PA, there is a very high degree of consistency (i.e., children aged under two years should have

no screen-time, older children should have very restricted screen time). Ireland was the only study country that did not provide advice on time spent being sedentary.

Allen + Clarke's review did not find national population advice on sleep for very young children although some evidence describing the importance of sleep for development and health outcomes was identified.

Key findings from the survey of Active Movement resource users

The survey results indicate that the Active Movement resources are currently used at least occasionally by 80 percent of survey respondents. They are used to promote fundamental movement skills for children aged under five years, to share ideas and to encourage children to be active. Stakeholders are aware of all of the resources but the brochures have the highest profile of the Active Movement resources. Users find that the individual resources meet their needs and are suitable, easy to use and understand, and that they are easy to access. Respondents identified positive outcomes when using the Active Movement resources including providing ideas about PA and encouraging young children to be active, understanding the importance of PA for young children and improving confidence. The main reason for not using the Active Movement resources is the availability of other similar resources used by respondents. It is not clear from survey responses as to why they prefer to use other PA/FMS resources.

Key conclusions

PA, time spent being sedentary and sleep are all important drivers of health and development outcomes. Low levels of PA can have adverse impacts on health for very young children and efforts to encourage participation have included the development of resources for those working with children. The Active Movement resources continue to be an important resource.

While evidence linking PA, time spent being sedentary and sleep to health outcomes is still developing, there is sufficient evidence suggestive of a dose-response relationship. There also appears to be a international consensus on the development of population health advice on physical activity and sedentary behaviours for children aged under five years. This consensus is underpinned by an well-accepted evidence base for some outcomes (especially those relating to adiposity). While there are some gaps in the evidence base, other countries have still decided to develop population health advice for their very young children. This advice sits within other national frameworks, including those which take a life-course approach to encouraging PA. Context-specific guidance, how to achieve physical activity recommendations and the appropriate number of hours that children should sleep or watch TV, for example, should be a component of any healthy-living education provided to children or caregivers. The high degree of consistency between the content of such national population health advice, the increasing rates of low levels of PA among very young children and the continued relevance of the Active Movement resources among those working with very young children means that it is timely for New Zealand to look towards developing similar advice for our under fives.

Options analysis

	Guidelines on physical activity and sedentary behaviour for children aged under-five years	FMS Resources
Option 1: Enhanced status quo	Continue with national population health advice on PA and sedentary behaviour that excludes children aged under five years.	Republish existing Active Movement resources using same content and delivery options but include more online availability.
Option 2: Develop national advice for very young children supported by existing government-prepared FMS resources.	Develop national guidelines on PA and sedentary behaviour for children aged under five years following a similar process as used in other countries (i.e., literature review + the development of consensus statements).	Republish existing Active Movement resources using same content and delivery options but include greater access to material electronically (i.e., consider app development).
Option 3: Refresh the full framework of advice for children aged under five years	Develop national guidelines on PA and sedentary behaviour for children aged under five years following a similar process as used in other countries (i.e., literature review + the development of consensus statements).	Develop a new complement of resources that both align to the national population health advice on PA and sedentary behaviour.

RECOMMENDATIONS ON NATIONAL POPULATION ADVICE

1. The Ministry of Health should consider developing national population health advice on the three behaviours: PA, sedentary behaviours and sleep for children aged under five years.

2. Where sufficient evidence exists, guidance should include information on type, context, intensity, frequency and duration of activity. Consideration should also be given to the wide variation in physical abilities of this age group: it should be relevant for, and specific to, infants, toddlers and pre-schoolers. It should also be relevant to the end-users of such advice.

3. An Expert Working Group should be established to consider the findings of this report and develop appropriate guidance on PA, sedentary behaviour and sleep for children aged under five years. The Expert Working Group should consider the following:

   General:

   a. An age-based framework consisting of infants (aged under 12 months), toddlers (aged one to two years inclusive) and pre-schoolers (aged three to four years inclusive).

   Physical activity:

   b. Infants should participate in unstructured, participative floor-based opportunities for play throughout the day including tummy time and safe, supervised water environments.
   c. Toddlers and pre-schoolers should participate in a wide range of activities that involve all of the main groups of muscles and basic movement skills in a variety of indoor and outdoor settings.
   d. Toddlers and pre-schoolers should engage in at least three hours of PA (spread throughout the day, every day) including at least some moderate-vigorous physical activity for pre-schoolers.

   Sedentary behaviour:

   e. Infants should be sedentary for limited periods at a time (excluding sleeping and eating)
   f. Pre-schoolers should be sedentary for no more than one hour at a time (excluding sleeping and eating).
   g. Children under two years should have no screen time. Screen time for older children should be limited to less than one hour per day (although less is better).

   Sleep

   h. All age groups should get an adequate amount of sleep for their needs.

RECOMMENDATIONS ON THE ACTIVE MOVEMENT RESOURCES

4. The Ministry should develop and promote resources and guidance material on the three behaviours: PA, sedentary behaviour and sleep for children aged under five years.

5. The content of the existing Active Movement resources should be expanded to include (where there is sufficient evidence) intensity, frequency, duration, type and context for PA, and advice about sedentary behaviour and sleep. Consideration should also be given to the FMS covered by the Active Movement resources.

6. Active Movement resources (subject to budget) should be available in a range of formats and languages, including those that take advantage of new technologies for communication and information dissemination (including social media channels and apps).

1. INTRODUCTION

1.1. Background

Sufficient physical activity (PA) and minimising time spent being sedentary in children supports a wide range of positive health outcomes including healthy weight. The World Health Organization's (WHO) 2015 draft report on Ending Childhood Obesity Report (ECHO Report) is a global report by the Commission on Ending Childhood Obesity. The draft ECHO Report proposes key policy actions to address childhood obesity worldwide, many of which are directly relevant in the New Zealand context.

One of the key considerations of the draft ECHO Report is to ensure children grow appropriately and develop healthy eating, physical activity and sleep behaviours in the first five years of life. The draft ECHO report states that the "first years of life are a critical period for establishing good nutrition and physical activity behaviours that have an impact on the risk of developing obesity". Appropriate, age and stage based fundamental movement skills (FMS), PA and sleep patterns are essential for helping to establish these behaviours in the first five years of life (along with good nutrition and breastfeeding) (WHO 2015). As noted by the WHO (2015), governments must take steps to coordinate and address childhood obesity, including implementing initiatives to reduce sedentary behaviours and providing guidance on healthy movement, sleep behaviours and appropriate time spent watching TV or using electronic devices for very young children.

In New Zealand, obesity is a major concern for the Government. In October 2015, the Minister of Health launched a package of initiatives to prevent and manage obesity in children and young people. Guidance material on physical activity for children aged under five years is included in the initiatives.

1.2. Scoping project: the Active Movement resources

In May 2015, the Ministry of Health contracted *Allen + Clarke* to complete a scoping project on PA resources for children aged under five years (i.e., the Active Movement resources). In light of the recent findings in the ECHO Report (WHO 2015), it is timely to review the existing Active Movement resources (which are now ten years old) alongside the current available evidence. This will help to determine if an update of the existing Active Movement resources is needed and, if so, what the most appropriate way to update the information is. The objectives of *Allen + Clarke*'s review were to:

1. review literature examining the effect of PA and FMS, sedentary behaviour and sleep on a range of health outcomes for children aged under five years
2. review population health advice on PA, sedentary behaviour and sleep from countries similar to New Zealand, and
3. undertake a survey of New Zealand stakeholders' views to determine which FMS resources they use (including the Active Movement resources), how they use them, how the Active Movement resources could be improved and what else they need.

Allen + Clarke's findings are presented in this report, which:

- summarises recently published academic literature
- summarises current population health advice on PA and FMS and sedentary behaviour for children aged under five years used in Australia, Canada, Ireland, the United Kingdom (UK) and the United States of America (USA)
- considers options for the future provision of advice on FMS and PA for parents and those working with very young children, including a gap analysis which compares current resources with up-to-date evidence and stakeholder needs, and
- makes recommendations on future directions for the Ministry's consideration.

1.3. What are the Active Movement resources?

Developed by SPARC (now Sport NZ) in 2003, the Active Movement resources provide FMS and developmental advice for children aged under five years (i.e., aged from birth to four years inclusive). These resources consist of 14 brochures, two DVDs/10 video clips and an information booklet. The resources describe what Active Movement is and the importance of FMS/developmental activities for very young children. They also include a range of activities to support a child's development of a specific skill. Brochures and the DVDs/videos organise activities by age group (i.e., newborns and infants, toddlers and young children). The DVDs also present activities and environments in which to explore PA and FMS.

Originally, Active Movement resources were available in hard and electronic format. They were provided by a range of organisations (including SPARC, regional sports trusts and others working with very young children). Now, most of the resources are available only in electronic formats although some hard copy resources remain available from regional sports trusts and others.

The Brochures include:

An Introduction to Active Movement

Sun, Safety & Nutrition

Developing Hands & Fingers

Developing Self-esteem

Walking, Running & Jumping

Developing Language

Massage & Touch

Eyes Need to Move Too!

Upper Body Development

Songs, Rhymes & Finger Plays

Tummy Time

Rolling & Crawling

Balance

Catching, Throwing & Kicking

Using the Environment

The DVDs are: New Beginnings, The Early Months, Baby on the Move, Wobbly Walkers, Growing Independence, Terrific Twos, Me at Three Fabulous Fours, and Ready For School.

2. GUIDANCE ON HOW TO READ THIS REPORT

This report contains two parts.

Part 1 (the report) summarises the literature and survey findings. It includes recommendations on the future provision of advice to parents and key stakeholders for the Ministry of Health's consideration.

Part 2 (the appendices) contains detailed material on the scoping project's findings, including a detailed literature review. There are four appendices:

1. Appendix A describes the project's terms of reference, methods used (including the search strategies), the assumptions and limitations associated with the report's findings and/or recommendations.
2. Appendix B details the findings of the literature review.
3. Appendix C describes national population health advice on PA, FMS and sedentary behaviour and children aged under five years used in Australia, Canada, Ireland, the UK, and the USA.
4. Appendix D summarises data collected through the survey of key stakeholders.

Definitions of key terms are included on page 4. Definitions are included on page 50.

3. METHODOLOGY

This report is informed by three evidence collection approaches:

1. A review of academic research published in 2011 and onwards
2. A review of population health advice provided in five comparison countries, and
3. A survey of New Zealand users' views of the Active Movement resources.

A brief overview of the methodology of each collection approach is discussed below. For a full description of the methodology see Appendix A.

3.1. Review of academic research

We reviewed academic literature that investigated the relationships that three health behaviours (ie, PA, sedentary behaviour, and sleep habits) have with several health outcomes among children aged under five years old (i.e., from birth to four years inclusive). Answers to the following questions were sought:

- What associations exist between PA and FMS, sedentary behaviour and sleep habits and adiposity (and childhood overweight/obesity), bone/skeletal health, motor skills development, mental health, cognitive development, cardiovascular health, and injury risk?
- What are the associations between PA and FMS, sedentary behaviour, and sleep?

3.1.1 Existing systematic reviews

Allen + Clarke's review was designed to add to (rather than duplicate) the evidence examined by the two recent systematic reviews of PA and health (Timmons et al 2012), sedentary behaviour and health (Le Blanc et al 2012). No systematic review of sleep and health outcomes was found. Timmons et al (2012) and Le Blanc et al (2012) reviewed articles published up to May 2011. Consequently, *Allen + Clarke* reviewed only articles published in 2011 and onwards.

3.1.2 Search strategy and findings

A comprehensive search strategy and inclusion process was undertaken to identify relevant articles. Seven academic databases were searched along with article bibliographies. The titles and abstracts of the identified documents were reviewed by our team's lead analyst and considered against inclusion criteria (see text box). Where inclusion criteria were met or where confirmation of inclusion was required, full-text papers were obtained and reviewed.

Inclusion criteria:

Published in or since 2011.

Study population aged 0 to 4.99 years.

Study measured one or more target health behaviours and one or more of target health outcomes.

General population study.

Intervention or prospective cohort study design. Cross-sectional studies, cross-sectional analyses, and multicomponent interventions where individual impact of the above mentioned health behaviours could not be determined were excluded.

In total, 219 relevant articles were identified for potential inclusion. From this, 28 articles (21 unique studies) met the inclusion criteria and have been included in *Allen* +

Clarke's review. These studies add to the body of evidence covered in the Timmons et al and Le Blanc et al studies.

3.2. Review of guidance advice from other countries

We reviewed population health guidance from other countries to determine what, if any, formal government advice is provided by those countries on the three health behaviours for children aged under five years. The review of guidance advice sought an answer to the following question:

- What population health advice exists on PA, FMS, sedentary behaviour and sleep for those aged under five years exists in key comparator countries (i.e., in Australia, Canada, Ireland, the UK and the USA)?

Allen + Clarke identified the key providers of population health advice in each country. We then searched each agency's website to identify guidance. To be included in the review of national guidelines, recommendations and advice about PA or sedentary behaviour needed to be national population health advice on either/and PA, FMS, sedentary behaviour or sleep from one of the key comparator countries. Key parameters applicable to all guidance material were developed and set of advice was then considered against these.

3.3. Survey of resource users' views on the Active Movement resources

Resource users' opinions are critical to informing options for updating the existing Active Movement resources (should this be required). The survey sought stakeholders':

- views on the existing Active Movement resources (i.e., whether Active Movement resources are used and why/why not, comments on the current content and format, access, and use of other existing resources), and
- preferences for new resources (i.e., type, content/required information, access and format).

3.3.1 Survey participants and response rates

Stakeholders from more than 80 organisations (including early childhood educators, parents, public health unit staff, regional sports trusts (RSTs), national sports organisations, health practitioners and Well Child/Tamariki Ora providers) were invited to participate in an online survey in August 2015. Recipients were also asked to send the survey to potentially interested participants (for example, Parents Centre). More than one stakeholder per organisation could respond.

A total of 225 completed survey responses were received. A further 42 survey responses were initiated but not completed (i.e., these are incomplete). Given that the survey was distributed through organisations' networks, it is not possible to determine a final response rate because the sample size denominator is unknown; however, we are confident that each of the potential participant groups is represented.

3.4. Assumptions and limitations

The findings and conclusions of the literature review need to be considered in light of the following limitations:

- Low number of studies is the key limitation. While 21 studies were reviewed, when split across three age-related groups, three health behaviours, and several health outcomes, the quantity of evidence for any one topic (eg, effect of PA on adiposity among toddlers) is sparse to non-existent.
- Only one New Zealand study met the inclusion criteria. Making specific recommendations regarding Māori, Pacific, or Asian population groups was not possible.
- Where evidence does exist, the quality of some studies was low. Quality was examined by considering methodological flaws (eg, very small samples size, measurement tool limitations), consistency of finding between studies, and the final results (eg, effect sizes, width of confidence intervals).
- Few direct comparisons between studies were possible due to heterogeneity in measurement (using different measurement approaches and definitions of PA, sedentary behaviour and sleep) and sample demographics.

As with any survey there are limitations. The sample size for whole survey and for individual datasets based on respondent type was unknown. The manner in which the survey was deployed meant that non-responders could not be measured. No response rate has been calculated. Partial completion of the survey was measured but the reason for partial completion was not explored. The use of a link sent via email or other publication meant that the targeted approach resulted in some respondent groups (such as educators) engaging to a greater level than other groups (such as helath practitioners). Language in the survey was not defined, so terms in the survey were up to the interpretation of the respondents (eg, sometimes', 'often' and 'mostly').

4. KEY FINDINGS

Part 4 of this report describes the key findings of the literature review, the review of other countries' guidance material and the stakeholder survey. Detailed findings are provided in:

- Appendix B (academic review findings)
- Appendix C (findings on other countries' population health advice), and
- Appendix D (end-user survey findings).

4.1. Key findings from the academic literature

This section presents a synopsis of the key findings from the full review of academic literature. The full review, including summary tables of study characteristics and findings, is included in Appendix B.

4.1.1. At-a-glance findings

Table 1 (overleaf) provides a high-level overview of study characteristics and findings. For each article, findings are presented as having a favourable, unfavourable or no association/impact. Dose-response relationships are also presented. This table shows that:

- there were 11 studies (13 articles) examining PA or FMS
- there were seven studies (eight articles) examining sedentary behaviour
- there were six studies (nine articles) examining sleep
- adiposity was the most frequently assessed health outcome and it was also the only outcome with findings from at least two studies assessing its association with PA, sedentary behaviour and sleep (i.e., all three health behaviours)
- few studies examined the health outcomes of sedentary behaviour, sleep habits, and cognitive abilities
- most studies were prospective cohort designs: findings relate mostly to associations rather than causation, and
- due to the absence of evidence, assessing relationships between all three health behaviours was not possible[1].

Overall, published evidence (in and since 2011) is limited, and in some areas non-existent. Hence, definitive conclusions could not be drawn. Where possible, tentative conclusions have been made and should be considered in light of the number and quality of studies reviewed.

[1] Associations that could be examined were PA and motor skills, PA and sedentary behaviour, and sedentary behaviour and sleep. No evidence was available to examine the PA and sleep relationship.

Table 1: At-a-glance table of findings per study reviewed

KEY √ Favourable association (better outcome) X Unfavourable association (poorer outcome) **[NA]** No association **[NI]** No intervention impact **DR** Dose response relationship **§** Finding differed between boys and girls. † Finding differed by weight status	**RCT_C** Cluster RCT **RCT_P** Parallel RCT **Cohort_P** Prospective cohort **PI** Post intervention	**De Vries et al (2014)** and **Sijtsma et al (2013)**: Both studies used data from the same cohort population, the Groningen Expert Center for Kids with Obesity (GECKO) Drenthe birth cohort **Annesi et al (2013a)** and **Annesi et al (2013b)** reported on data from the same intervention study. **Fuller-Tyszkiewicz et al (2012)** and **Magee et al (2014a, 2014b, 2014c)**: All articles based on data from the same cohort study - Longitudinal Study of Australian Children. **Bonuck et al (2012, 2015)**: Both articles based on data from the same cohort study, the Avon Longitudinal Study of Parents and Children. Articles placed in toddler section because the first sleep measurement was taken at aged 18 months. **Age (baseline)** represented mean age of age range at baseline. **Age/timeframe (follow up)** represented mean age/age range at follow-up or timeframe between measurement points. If multiple ages are provided, indicates study had multiple follow-ups Note: All out of scope findings are provided in full in the detailed findings tables in Appendix B.

	Reference	Study design	Sample size	Age (baseline)	Age/timeframe (follow up)	Exposure	OUTCOME						
							Adiposity /obesity	Psycho-social Health	Cognitive abilities	PA	Motor skills	Sedentary behaviour	Sleep
PA Articles	Infants												
	De Vries et al 2014	RCT_C	143	Two weeks	2.5 years	PA and motor skill stimulation advice to parents during infants first year of life.	√ § [NA]			[-]	[NA]		
	Jorge et al 2013	Non-RCT	12	Seven months	Four months later	One swim class per week for four months.					[NI] √		
	Benjamin Neelon et al 2012	Cohort_P	741	Infant	Three years	Earlier age at which achieved motor milestones (eg, sitting, walking).	√ [NI]						
	Hitzert et al 2014	Cohort_P	74	Three months	Five to six years	Age appropriate movement patterns during infancy.			√ x [NA]		X √ [NA]		
	Schmidt Morgen et al 2013	Cohort_P	25,148	Five months	Seven years	Earlier age of achieving motor milestones (eg, sitting, walking).	X [NA]						
	Sijtsma et al 2013	Cohort_P	1,283	Nine months	24 months	Time spent moving unrestrictedly at aged nine months.	√ [NA]						
	Toddlers												
	Wang et al 2012	Cohort_P	62,944	1.5 years	Three years	Earlier motor skill achievements.			√				
	Pre-schoolers												
	Annesi et al 2013a	RCT_C	338	4.7 years	Eight weeks	Start for Life initiative. 30 minute daily structured PA for eight weeks.				os		[NI]	
	Annesi et al 2013b	RCT_C	1,154	4.4 years	Nine months	As above, Start for Life	√ †			os		[NI]	

	Reference	Study design	Sample size	Age (baseline)	Age/timeframe (follow up)	Exposure	OUTCOME						
							Adiposity /obesity	Psycho-social Health	Cognitive abilities	PA	Motor skills	Sedentary behaviour	Sleep
						initiative but for nine months.							
	O'Dwyer et al 2013	RCT_C	240	4.5 years	Six weeks and six months PI	Six-week active play intervention.				os		[NI]	
	Bonvin et al 2013	RCT_C	648	3.3 years	PI (nine months)	Youp'là Bouge initiative: PA intervention with individual, pre-school and communities strategies which included recommended and compulsory intervention strategies.	[NI]	[NI]		os	[NI]		
	Bellows et al 2013	RCT_C	201	Three to five years	PI (18 weeks)	Mighty Moves initiative: 18 weeks of structured FMS sessions.	[NI]			[NI]	os		
	Zhou et al 2014	QE	357	4.5 years	PI (12 months)	Policy driven, multi strategy PA intervention which included nutrition component.	os				√		
Sedentary behaviour Articles	Infants												
	Sijtsma et al 2013	Cohort_P	1,283	Nine months	24 months	Time spent using a baby seat (eg, child seat).	√ X						
	Toddlers												
	Marinelli et al 2014	Cohort_P	1,245	Two years	Four years	Higher daily TV viewing.							X DR
	Fuller-Tyszkiewicz et al 2012	Cohort_P	4,724	2.29 years	4.25 years and 6.32 years	Higher weekly TV viewing.	X						
	Pre-schoolers												
	Yilmaz et al 2015	RCT_P	412	3.5 years	PI (eight weeks) and two, six and nine months post intervention	Eight-week family based intervention targeting reduced screen time.	[NI]	√				os	
	Birken et al 2012	RCT _P	160	Three years	Four years	One ten-minute behavioural counselling to reduce screen time.	[NI]					os	
	Lillard and Peterson 2011	QE	60	Four years	Same day	Watching a nine-minute fast paced television cartoon.			X				
	Hinkley et al 2014	Cohort_P	3,604	4.3 years	6.3 years	Higher electronic media use (TV and computer use).		X § DR [NA]					
	Magee et al 2014c	Cohort_P	3,427	Four to five years	Six to seven years Eight to nine years	Higher media use and TV viewing.							X [NA] DR
Sleep	Infants												
	Price et al 2012	Cohort_P	326	Four months	Seven months, 12 months, 24 months, six	Parent -perceived child sleep problems.		[NA]					

Reference	Study design	Sample size	Age (baseline)	Age/timeframe (follow up)	Exposure	OUTCOME						
						Adiposity /obesity	Psycho-social Health	Cognitive abilities	PA	Motor skills	Sedentary behaviour	Sleep
				years								
Taveras et al 2014	Cohort_P	1,046	Six months	Annually between one and seven years	Curtailed sleep (shortened sleep relative to average sleep duration).	X						
Magee et al 2014b	Cohort_P	2,926	Birth to one year	Six to seven years	Short sleep.		X [NA]					
Toddlers												
Carter et al 2011	Cohort_P	244	Three years	Six-monthly betweena ged three and seven years	Short sleep.	X DR						
Bonuck et al 2012	Cohort_P	11,049	Six months	Eight years	Presence of behavioural sleep problems.			X				
Bonuck et al 2015	Cohort_P	1,899	Six months	Seven, 10 and 15 years	Short sleep.	X [NA]						
Sivertsen et al 2015	Cohort_P	32,662	18 months	4.4 years	Short sleep.		X DR					
					Higher frequency of waking up during the nights.		X DR					
Pre-schoolers												
Magee et al 2014a	Cohort_P	2,984	Four to five years	Six to seven years Eight to nine years	Short sleep.	X						
Magee et al 2014c	Cohort_P	3,427	Four to five years	Six to seven years Eight to nine years	Short sleep.						X DR	

4.1.2. Key insights

All three health behaviours impact health outcomes

Based on the best-available, but limited evidence, all three health behaviours (PA/FMS, sedentary behaviour and sleep habits) appear to be associated with health outcomes, to varying degrees.

Physical activity

For PA, the available evidence suggests:

- higher PA levels have a positive association with adiposity for infants
- better motor skills are positively associated with better communication skills for toddlers, and
- PA/FMS interventions had limited impact on improving motor skills sedentary behaviour, or adiposity indicators, in pre-schoolers.

Given the lack of available evidence or low quality evidence (i.e., small sample sizes and limited numbers of studies), conclusions could not be drawn for the effect of PA on psychosocial health indicators, cognitive abilities (for infants and toddlers), motor skills (for infants), cardiovascular health (all age groups), risk/injury (all age groups) or sleep (all age groups).

Allen + Clarke's findings align with some of the conclusions drawn by Timmons et al (2012) from their systematic review of evidence on PA and health which found:

> *"… in infants, there was low- to moderate-quality evidence to suggest that increased or higher physical activity was positively associated with improved measures of adiposity, motor skill development and cognitive development. In toddlers, there was moderate-quality evidence to suggest that increased or higher physical activity was positively associated with bone and skeletal health. In pre-schoolers, there was low- to high-quality evidence on the relationship between increased or higher physical activity and improved measures of adiposity, motor skill development, psychosocial health, and cardiometabolic health indicators."*

Sedentary behaviour

For sedentary behaviour, higher screen-time (including TV viewing) was associated with poorer health outcomes. The available evidence suggests that higher or increased TV viewing is associated with higher adiposity in toddlers. The TV-BMI relationship is bi-directional (i.e., toddlers who watch more TV had higher BMI values in later childhood and toddlers with higher BMI spent more time watching TV in later childhood). More time engaged with electronic media is associated with poor sleep outcomes for toddlers and pre-schoolers.

Other key findings include that:

- high computer use by pre-schoolers (from high income families only) is associated with less sleep
- media use is negatively associated with psychosocial health indicators in pre-schoolers
- type of TV content (eg, fast-paced content) decreases cognitive abilities (i.e., executive functioning), temporarily among pre-schoolers, and
- interventions targeting reduced TV viewing had limited impact on adiposity in pre-schoolers.

Given the lack of available evidence or low quality of evidence, conclusions could not be drawn for the effect of sedentary behaviours on sleep (for infants), psychosocial health indicators (for infants), cognitive abilities (for infants and toddlers), motor skills (all age groups), cardiovascular health (all age groups) or risk/injury (all age groups).

Allen + Clarke's findings align with some of the conclusions drawn by Le Blanc et al's (2012) review of evidence on sedentary behaviour and health which found:

> *"…low- to moderate- quality evidence to suggest that increased television viewing is associated with unfavourable measures of adiposity and decreased scores on measures of psychosocial health and cognitive development. No evidence existed to indicate that television viewing is beneficial for improving psychosocial health or cognitive development. In several instances a dose–response relationship was evident between increased time spent watching television and decreased psychosocial health or cognitive development."*

Sleep

Poor sleep habits were consistently associated with poorer health outcomes in later childhood. Infants, toddlers and pre-schoolers with high curtailed sleep or short sleep times were found to have higher BMI values, increased fat mass, greater risk of obesity, lower health-related quality of life, and/or higher media use and TV viewing. Persistent short sleepers had lower physical, emotional and social functioning outcomes.

Sleep is impacted by media use and impacts adiposity

Dose-response relationships were reported for media use-sleep and sleep-adiposity associations.

For electronic media use, each additional hour of daily TV between aged two and four years was associated with decreased sleep time at aged six years (Marinelli et al 2014). A one hour mean increase in media use was associated with a 3.6-minute mean decrease in sleep duration (Magee et al 2014c). A one hour mean decrease in sleep duration was associated with a 4.8 to six minute mean increase in media use (Magee et al 2014c). More media use (TV/computer) was linked to increased risk of emotional problems and poor family functioning (Hinkley et al 2014).

For sleep, New Zealand research by Carter et al (2011) showed that each additional hour of sleep per night between aged three to five years was associated with a 0.39 unit reduction in BMI and a 0.48 reduction in fat mass index at aged seven years.

Dose-response relationships were also reported in the systematic reviews by Timmons et al (2012) and Le Blanc et al (2012). These authors reported dose-response relationships between: PA and adiposity (inverse), and TV exposure with adiposity, psychosocial health (inverse) and cognitive development (inverse).

All health behaviours were associated with adiposity indicators

Among the health outcomes, adiposity was the most frequently assessed. Based on prospective cohort evidence, all three health behaviours appear to be associated with adiposity. Unrestricted movement for five or more hours a day at aged nine months was associated with lower increases in weight-related indices between aged nine months and 24 months (Sijtsma et al 2013). Pre-schoolers who watch more weekly TV at aged two years had higher BMI as a pre-schooler at aged four years and during childhood at aged six years (Fuller-Tyszkiewicz et al 2012).

Among New Zealand children, increased sleep time as a toddler and pre-schooler was associated with increased reduction in BMI during mid-childhood (Carter et al 2011). In contrast, interventions aimed at increasing PA or reducing TV viewing had limited- to-no-effect on changing adiposity indicators. A potential reflection of limitations of the interventions themselves and study design limitations.

Evidence on the associations between health behaviours is limited

A bi-directional relationship between sleep and electronic media use was found. Short sleepers tend to have higher levels of TV viewing and screen use and higher screen use was associated with poorer sleep habits (Magee et al 2014c). Limited to no evidence exists for the PA-sedentary behaviour or PA-sleep relationships.

Intervention studies show limited association between PA and FMS

In contrast to cross-sectional evidence which supports a PA-FMS link (Robinson et al 2012; Bellows et al 2013; Williams et al 2008), RCT evidence is not so convincing. Three of the four interventions (De Vries et al 2014; Bellows et al 2013; Bonvin et al 2013) found no effect on motor skills among infants and pre-schoolers. The one initiative (Zhou et al 2014) that impacted a range of motor-skill related fitness tests (eg, balance, sprinting) took a socio-ecological approach to behaviour change and included individual-, child-centre-, and community-based strategies. Also, the strategies implemented were more aligned with the outcomes measured, in that the programme itself and the indicators assessed were both focused on FMS.

Interventions had low success rate

Interventions targeting increased PA or a reduction in media use had low success in changing health outcomes.

Of the eight interventions reviewed, six were PA focused (De Vries et al 2014; Zhou et al 2014; Annesi et al 2013a; Annesi et al 2013b; Bonvin et al 2013; Bellows et al, 2013; O'Dwyer et al 2013) and two focused on screen use (Yilmaz et al 2015; Birken et al 2012). Each intervention targeted one or more health outcomes. No studies assessing sleep intervention were identified. The ability of sleep interventions to improve future health, therefore, remains unknown.

A range of intervention modalities were tested from active play through to structured/organised PA opportunities and reducing screen time. Infant-focused interventions were brief, simple, and pragmatic (nurse advice at check-ups, swimming classes). For toddlers and pre-schoolers, all interventions were delivered through childcare centre settings. Behaviour change theory underpinned most interventions, which was a key strength of the interventions reviewed. Intervention delivery was often through a single environment (i.e., childcare centre and baby clinic). Taking a holistic life-course approach may lead to better success. This may involve implementing initiatives that span more than one environment and consider the impact of transition periods (eg, from pre-school to school) to provide persistent messaging and support.

Intervention strategies and implementation may have contributed to the low success rate. Most interventions were of short duration, lacked long term follow-up, and/or were not intensive or different enough to exert an effect above usual practice control. For one study (Bonvin et al 2013) intervention strategies were not compulsory, potentially leading to inconsistent implementation. Study design issues may have contributed also. Power calculations were infrequently reported and outcomes of interest were often secondary outcomes. Thus, many intervention studies may have been insufficiently powered to detect change.

4.2. Key findings on other countries' guidelines and recommendations

This section describes national guidance and recommendations on PA, FMS and sedentary behaviour for children aged under five years used in Australia, Canada, Ireland, the UK, and the USA.

No guidance on PA for children aged under five years published by international or regional governance bodies like the World Health Organization[2] was identified.

National population health advice on PA for children aged under five years exists in each study country. All, except Ireland, also provide advice on sedentary behaviour for this age group, as described in Table 2 (overleaf).

[2] The World Health Organization's recommendations start for children aged over five years: no similar comparable advice exists for infants, toddlers and pre-schoolers.

Table 2: PA and sedentary behaviour advice by country

Country	PA Guidelines	Guidelines on sedentary behaviour and screen time	Sleep	Systematic review of evidence available?
Australia	National Physical Actvity Recommendations for Children (0-5 years)	Included in the National Physical Activity Recommendations for Children (0-5 years)	×	×
Canada	Canadian Physical Activity Guidelines for the Early Years	Canadian Sedentary Behaviour Guidelines for the Early Years	×	✓
Ireland	National Guidelines on Physical Activity for Ireland	-	×	×
UK	Physical Activity Guidelines for Early Years (under five years) - for children who are capable of walking Physical Actvity Guidelines for Early Years (under five years) - for infants who are not yet walking	No separate guideline but advice included in UK's PA guidelines	×	✓
USA	Healthy Activity, Screen Time and Sleep in the Early Years	Healthy Activity, Screen-time and Sleep in the Early Years	×	×
	Active Start: Physical Activity Guidelines for Children Birth to Five Years	-	×	×
	Caring for Our Children: National Health and Safety Performance Standards	Included in the Performance Standards	×	×

Kahlmeier et al (2015) conducted a systematic review and analysis of PA guidelines for European countries. The authors concluded that few of the 21 European nations

that have developed national PA guidelines include children aged under five years (except for the United Kingdom, Ireland and Finland). Finland's guidance is only available in Finnish and therefore is not included in *Allen + Clarke*'s review.

Generally, existing PA and sedentary behaviour guidelines and recommendations focus exclusively on children aged under five years, except for Ireland's guidance which focuses on children aged two to 18 years. Ireland is also the only country included in *Allen + Clarke*'s review that does not provide PA or sedentary recommendations for infants or toddlers aged under two years or any recommendations on sedentary behaviour.

The countries included in the review have only one set of national population health advice except for the United States, which has a range of different but complementary advice (including recommendations developed in the context of obesity prevention initiatives, by its National Association for Sport and Physical Education and performance standards for early education and care settings). Only one country provides guidance on FMS (Canada). This advice is consistent with (although more detailed than) its PA guidance.

4.2.1. Countries' PA advice and recommendations

National population health advice and recommendations on type, intensity, context, duration, and frequency of PA exists for all countries.

Coverage

All countries included in *Allen + Clarke*'s review recognise that there are significant differences in physical development and ability within the under fives age population. Most countries present advice based on infants (aged from birth to one year), toddlers (aged between one and three years), and pre-schoolers (aged between three and five years). The UK uses a defined developmental stage (i.e., not walking or walking), correlating to the infants and toddlers and pre-schoolers groupings used in the other countries.

Content

All countries' advice provides contextual information about the importance of PA for children aged under five years. This is usually in the form of high-level statements about the benefits of PA in terms of physical, emotional and mental development. Most also include practical advice or tips that readers can use to promote PA (and/or reduce sedentary behaviour or support PA among currently inactive children) among this population. These resources also include links to other resources to promote PA.

As well as general material focused on promoting PA, all countries provide recommendations on the types of PA that children aged under five should be doing and information on how much, when and how often. There is a high degree of consistency between countries on the detail for each age group or developmental stage (including within the three resources used in the USA). Further detail about the content of the recommendations and guidance is described in Table 3 (overleaf) and in Appendix C of this report.

Table 3: Key features of national population health recommendations on PA for children aged under five years

Country	Age groups	Type and context	Intensity	Frequency and duration
Australia	Infants (birth to one year) Toddlers (one to three years) Pre-schoolers (three to four years)	Infants: FMS and unstructured floor-based play Toddlers and pre-schoolers: a range of activities in a range of environments	Not specified	Infants: not specified Toddlers and pre-schoolers: at least three hours per day, throughout the day
Canada	Infants (birth to one year) Toddlers (one to two years) Pre-schoolers (three to four years)	Infants: interactive floor play Toddlers and pre-schoolers: a range of activities in a range of environments	Not stated Any intensity	Infants: several times per day Toddlers and pre-schoolers: at least three hours per day,throughout the day More PA provides greater benefits
Ireland	Children aged two – 18 years	Toddlers and pre-schoolers: a range of activities in a range of environments	Moderate-vigorous	At least one hour per day and at least three times per week
UK	Non-walkers Walkers	Non-walkers: Floor and water play Walkers: a range of activities in a range of environments	Not specified Any intensity	Non-walkers: not specified Walkers: at least three hours per day, throughout the day
USA	Infants Toddlers Pre-schoolers	Infants and toddlers: unstructured PA including outdoor play for toddlers. Pre-schoolers: unstructured and structured play including outdoor play	Includes vigorous activity for toddlers and pre-schoolers (60-90 minutes per day)	Infants: not specified OR stated generally: short periods of time regularly throughout a day) Toddlers: 60-90 minutes each eight-hour day, undertaken in short bursts OR at least 60 minutes per day OR 60-90 minutes of outdoor play and 60-90 minutes of vigorous PA per eight hour day Pre-schoolers: 90-120 minutes each eight hour day, undertaken in short bursts OR at least 60 minutes of unstructured PA and at least 60 minutes of structured PA per day OR 60-90 minutes of outdoor play and 90-120 minutes of vigorous PA per eight hour day.

Common findings include:

- Type: advice generally focuses on unstructured, participative play for all age-groups/developmental stages. Tummy time and FMS like reaching, grasping, pulling, and pushing is identified for infants. Toddler and pre-schooler recommendations focus on movements involving all of the main groups of muscles/basic movement skills like walking, running, and jumping.
- Context: all guidelines provide advice focused on unstructured play with floor-based tummy time and safe water environments for infants and ensuring a variety of activities in indoor or outdoor settings for older children.
- Intensity: no country provides advice on intensity for infants. There is generally limited information on intensity for toddlers and pre-schoolers but some countries state MVPA for children aged three or four years.
- Duration and frequency for infants: there is limited detail on expected duration for infants with most advice recommending that opportunities for movement occur throughout the day.
- Duration and frequency for toddlers and pre-schoolers: the duration and frequency advice differs for the older age-groups although there is consistency between three of the five countries with most countries opting for three hours of PA spread throughout the day. Only one country (Ireland) recommends that children be significantly less active than this and this recommendation may reflect the fact that Ireland's guidelines are for children aged two to 18 years.

Format

All countries provide summarised guidance, which can be used by parents, educators, caregivers and others involved in very young children's lives.

4.2.2. Countries' sedentary behaviour recommendations

Most study countries have developed advice on sedentary behaviour (except Ireland). Australia and Canada have developed stand-alone advice on sedentary behaviour which is nested under existing PA guidance frameworks. The UK and the USA include advice about sedentary behaviour in PA guidance recommendations.

Coverage

The age groups covered by sedentary behaviour recommendations mirror those groups included in PA advice (i.e., up to aged five years). Most advice splits sedentary advice into two rather than three groups: children aged under two years (i.e., infants and younger toddlers) and children aged between two and five years (i.e., older toddlers and pre-schoolers).

Content

All countries' advice includes contextual information about the importance of reducing young children's time spent being sedentary (including considering the impact of screen time). This is usually in the form of high-level statements about patterns of sedentary behaviours and/or the evidence linking this to health outcomes.

Most include practical advice or tips that readers can use to reduce sedentary behaviour or support PA among currently inactive children in this population.

As with PA, there is a high degree of consistency in the advice provided on sedentary behaviour. For example, all countries recommend that infants have limited opportunities to sit in equipment that restrains them. US advice takes this further, specifying that infants be sedentary for periods of no more than 15 minutes at a time. Similar approaches are used for older children (i.e., no more than 30 minutes for older children in the USA or no more than one hour for other countries).

All countries recommend that children aged under two years have no screen time (i.e., no television or use of electronic devices). Children aged between two and five years old should limit television and use other electronic media for less than one hour per day (Australia, Canada). “Less is better” messaging is consistent in Australia and Canada. US guidance is similar but notes that while zero viewing hours are preferable, in reality it should be limited to less than 30 minutes per week. Further detail about the content of sedentary behaviours recommendations and guidance is described in Table 4 (below) and in Appendix C of this report.

Table 4: Key features of national population health recommendations on sedentary behaviour for under fives

Country	Guidance	Age groups	Frequency and duration	Screen time
Australia	Stand-alone guidance nested within the *Get Up and Grow* framework.	Provides two sets of advice: one set for children aged under two years and another set for children aged two to five years.	Children aged under five years should not be sedentary, restrained, or kept inactive, for more than one hour at a time (except during sleep).	Those aged under two years should not spend time watching TV or using other electronic media. Those aged two to five years: sitting and watching TV or using electronic media should be limited to less than one hour per day.
Canada	A stand-alone guideline.	Provides two sets of advice: one set for infants and younger toddlers and one set for older toddlers and pre-schoolers.	Minimise the time that all age groups spend being sedentary during waking hours or sitting or being restrained for more than one hour at a time.	Those aged under two years: screen time is not recommended. Children aged two to four years: limit screen time to under one hour per day but less is better.

Country	Guidance	Age groups	Frequency and duration	Screen time
Ireland	No advice on sedentary behaviour provided.	-	-	-
UK	Advice contained within PA Guidelines.	Children aged under five years.	Not specified	Not specified
USA	Healthy Activity, Screen-time and Sleep in the Early Years	Children aged under five years.	Limit the time that infants spend in restricted seating like swings, strollers, exersaucers and high chairs. Ensure that children of all ages are not sitting longer than 15- to 30-minute intervals, unless during meals or naptime.	Those aged under two years: keep screen media turned off at all times. Children aged two to four years: in a childcare setting, limit screen time (including TV and electronic devices) to no more than 30 minutes per week.
	Advice included in *Caring for Our Children: National Health and Safety Performance Standards*	Children aged under six years.	Infants should not be seated for more than 15 minutes except during mealtimes and naps. Only use equipment like exersaucers for limited periods of time. No advice is provided on sedentary behaviour for older children.	Those aged under two years in an early childhood setting: media and computer use is not permitted. Children aged two and older in an early childhood setting: limited viewing to not more than 30 minutes per week.

4.2.3. Countries' sleep recommendations

No national population health advice on sleep was identified for Australia, Canada, Ireland and the United Kingdom. The National Heart, Lung and Blood Institute (USA) provides some guidance on quantum for children aged under five years: newborns require 16-18 hours per night; pre-schoolers require 11-12 hours per night. It notes variance between individual sleep requirements.

4.2.4. Developing national population health advice on PA and sedentary behaviour

Limited information on the processes used to develop national population health advice on PA for children aged under five years was found. Detailed advice was only available for Canada: development followed a robust approach (as described by Tremblay et al 2012a, 2012b). Children aged under five years were not initially included in Canada's PA population health advice framework. Recommendations to include very young children were developed following two extensive systematic reviews that compiled and assessed evidence examining the relationships between PA and health outcomes and sedentary behaviour and health indicators (i.e., LeBlanc et al 2012; Timmons et al 2012). Information on frequency, intensity, duration, context and type could not be determined from the available evidence (including the Timmons and Le Blanc reviews). A consensus meeting was convened, the systematic reviews were discussed and draft guidance material was prepared for consultation before finalisation (including application of AGREE II and GRADE[3] processes). This process involved the following key steps:

1. The establishment of a leadership team to guide the process
2. Development of a comprehensive systematic review to investigate evidence on the relationship between PA and health outcomes for children aged under five years
3. Review of other countries' advice on PA and sedentary behaviour
4. Consensus seeking and stakeholder engagement
5. Development of population health advice, communications, dissemination and evaluation/proposed revision strategy (yet to be completed).

The UK has recently followed the Canadian's work (including leveraging off the systematic reviews). In the USA the guidelines were developed following reviews of guidance of other organisations within the USA. No information was available regarding Australia or Ireland.

4.2.5. Summary

Allen + Clarke looked at the PA sedentary behaviour and sleep recommendations for children aged under five years from five other countries. All of these countries have specific recommendations relating to PA for these children. This includes advice on frequency and duration of PA, type and context for either age group (i.e., infants,

[3] AGREE II and GRADE are tools to assess the quality of guidelines.

toddlers and pre-schoolers) or developmental stage (i.e., walking or not walking). Other countries generally provide guidance on sedentary behaviour (except Ireland). Specific advice on limiting the frequency and duration of sedentary episodes is provided. Guidance on sedentary behaviour is either provided as a set of stand-alone recommendations or is nested within PA advice. Few countries provided national population advice on sleep requirements for children aged under five years, although some US advice exists. This advice is not clearly linked to the evidence base describing the relationships between sleep and health outcomes.

4.3. Key findings from the survey

Review of the Active Movement resources requires consideration of users' opinions. A short survey was sent to a range of Active Movement resource stakeholders including early childhood education providers, RSTS, health providers and parents. The purpose was to develop an understanding about the level of awareness of existing Active Movement resources among potential users. We asked about:

- the level of use of Active Movement resources (eg, frequency of use, in what circumstances and with whom, for what purpose, and whether practice changes occurred following the receipt of advice)
- use of other resources on FMS and PA for very young children
- perceptions about usability of the existing Active Movement resources, and
- the Active Movement resources' content and format (including what works and what does not, what could be improved).

4.3.1. Response rate and demographic profile

A total of 267 completed survey questionnaires were received. Of these, 225 were fully completed and a further 42 were partially completed. Responses were received from each user type, demographic and geographic category.

The findings discussed in this report are based on the fully completed surveys. Incomplete surveys dropped off at or following the demographic questions, or within the first three questions of the survey proper (i.e., before they had provided substantive information about use of the Active Movement resources). These were not included in the analysis.

4.3.2. Key findings

The following sections describe the key findings from the survey organised by awareness, use, format, suitability and views on the future of the Active Movement resources.

Awareness

A total of 79 percent of survey respondents know about the Active Movement resources. There are some differences between categories of respondent which may reflect a broader awareness issue. Doctors and respondents working with Māori and Samoan children indicated lower levels of awareness; however, this finding may

reflect the small number of respondents in these categories (and as such, reflect an individual rather than a group need).

Use

The existing Active Movement resources are currently used by respondents: 52 percent had used them within the previous six months and one-third had used them in the last month. Thirty-five percent of respondents had not used the Active Movement resources in more than one year.

Respondents generally use the Active Movement resources to generate ideas about supporting FMS development in very young children (64 percent of respondents) and as a mechanism to share information and educate about PA and FMS for the under fives (60 percent).

Format

Eighty-three percent of respondents said that they used the resources mostly in hard-copy. Only six percent accessed these resources. This contrasts with responses to a question on preferred format, in which 66 percent of respondents noted that they would prefer resources in both hard copy and electronic formats. It is not clear from the data whether users prefer one format over the other or whether the findings reflect the availability of the resources or awareness of the range of Active Movement resources available.

The brochures (or packs of brochures) were the most commonly used Active Movement resources. DVDs are used but are less popular than the brochures. Respondents did not indicate whether certain brochures were viewed as being more or less useful and relevant than others. When asked about the format that they would like to see any future Active Movement resources in, brochures, DVDs and apps were all popular options.

Suitability

Stakeholders were asked to rate the Active Movement resources on a range of variables. These questions were designed to determine the level of utility of the current resources and user satisfaction with them. The analysis of these items only looked at respondents' answers where they related to a specific Active Movement resource that they had used. Overall:

- there were very high levels of satisfaction with the way that the current Active Movement resources meet users' needs (with at least 70 percent of respondents rating that the Active Movement resource that they used met their needs "very well" or "mostly")
- the Active Movement resources are very easy to use and very easy to understand (with more than 90 percent of respondents rating that the Active Movement resource that they used was "very easy" or "mostly easy" to use and understand), and
- they are easy to access for most (70 percent) but 30 percent of users found them somewhat difficult or difficult to access.

There was a high correlation between the information that users said that they want and the reasons for using the Active Movement resources (i.e., information about activities to do with young children so that they can then encourage children in their care to be active).

The use of other resources was a common factor among those who used or did not use the Active Movement resources, indicating that the existing Active Movement resources may not currently be filling all of stakeholders' needs. Reasons for preferring to use other resources were not explored in this survey. Forty-one stakeholders did not use the Active Movement resources primarily because they use other resources. Other reasons for not using the Active Movement resources included lack of awareness of the Active Movement resources or a perceived lack of relevance to their jobs. If awareness is a key factor in the lack of use, there may be opportunities to increase awareness and boost use.

5. DISCUSSION AND GAP ANALYSIS

Part 5 of this report discusses the findings of the literature review and the survey and describes the implications of these for the current Active Movement resources. This includes a gap analysis covering national population health advice on PA, sedentary behaviour and sleep as well as discussion of the current Active Movement resources themselves.

5.1. National population health advice on PA, sedentary behaviour and sleep

Low physical activity is fast becoming the social norm in most countries, and is an important factor in the obesity epidemic (WHO 2015). PA, sedentary behaviours, and sleep habits are all important issues for the very young especially in the context of New Zealand's levels of childhood overweight and obesity (Ministry of Health 2014). Further, the World Health Organization (2015) recommends that:

> *"…Governments could take action to reduce sedentary behaviours and promote physical activity in children and adolescents and could…inform by…providing guidance on education for healthy movement and sleep behaviours and appropriate use of screen-based entertainment for children, adolescents, parents, caregivers, teachers and health professionals…"*

5.1.1. New Zealand's current situation

In New Zealand, statistics on young children's physical activity are not routinely collected as part of the New Zealand Health Survey; however, the 2013/14 Health Survey showed that over half of children aged two to four years old watched two or more television per day. This figure is higher in Māori and Pacific children who also have much higher rates of obesity than non-Māori/non-Pacific children of the same ages) (Ministry of Health 2014).

The Active Movement resources provide information and tips for those working with infants and young children to encourage PA and the development of FMS. But, New Zealand has no specific national population health advice describing frequency, intensity, context, duration and type requirements for PA or sedentary behaviour and sleep for children aged under five years.

New Zealand has national PA recommendations for older children and adults (i.e., the New Zealand Physical Activity Guidelines, which provide advice about the type, context, frequency and duration of PA requirements for these other age groups). Advice for very young children is missing from this framework.

5.1.2. National population advice on PA in comparable countries

In contrast to New Zealand, Australia, Canada, the UK and the USA provide PA and sedentary behaviour recommendations for children aged under five years (including infants, toddlers and pre-schoolers). Ireland provides PA advice for toddlers and pre-schoolers. Recommendations about type, intensity, frequency, duration and context

are highly consistent between countries (eg, three hours of PA spread through the day every day for older children, limited sedentary time, and very restricted screen-time – including no screen time for children aged under two years). Each country provides national recommendations that consider the differences in the physical abilities of children in the under fives age group.

5.1.3. The development of national population advice on PA for New Zealand's very young children

Published academic evidence linking PA, sedentary behaviour and sleep with healthy growth and development for very young children is limited, but growing. Most evidence relates to pre-schoolers (rather than infants and toddlers), with adiposity/obesity being the most frequently studied health outcome. Based on research available in June 2015, there is sufficient evidence to suggest all three health behaviours - PA, sedentary behaviour, and sleep habits - are associated with health outcomes to varying degrees. Higher levels of PA, less sedentary time and adequate sleep time appear to support healthy growth and development. Together, the literature reviewed in this report (which builds on prior systematic reviews that were used to inform recommendations for other countries) and New Zealand's existing population framework for PA recommendations provide direction for the development of recommendations and advice for New Zealand.

5.1.4. Possible content of New Zealand-specific national population health advice on PA for very young children

Research targeting children aged under five years old is only starting to emerge and is not yet sufficiently large enough or varied enough to provide definitive recommendations to inform public policy or national population health advice. Very limited New Zealand-specific evidence exists. Information on a dose-response relationship is also limited. Such evidence is crucial to help determine how much PA, sedentary behaviour and sleep is necessary to promote healthy development for under fives.

While more high-quality studies, especially dose-response studies, are needed to strengthen the existing knowledge base and evidence on age-appropriate PA, sedentary behaviour and sleep habits recommendations, the academic research findings outlined in this report provide an overview of 'best-available' evidence, which can help inform guideline development processes. This evidence can be complemented with alternative sources of knowledge like reviewing guidelines from other countries, examining PA monitoring data to identify current levels and consultation with key personnel from academia, government, and community organisations. This is the approach undertaken by Canada in the development of its guidelines.

5.1.5 What advice could be developed?

Even in the absence of a strong evidence base outlining a clear dose-response relationship between PA, sedentary behaviours, sleep and health outcomes, it is possible to prepare guidance based on other countries' advice about what might be relevant for New Zealand's children.

Based on the findings of this report, advice:

- should include:

    1. Information about the importance of PA, reducing sedentary behaviour and sleep for children aged under five years (in terms of health outcomes and FMS)
    2. Recommendations on the type, context, duration, frequency and intensity of PA for different age groups or developmental stages within the under fives population
    3. Recommendations on time spent being sedentary for different age groups or developmental stages within the under fives population, and
    4. Advice on implementing such recommendations, especially in terms of providing ideas to encourage activity (which could be contained in resources separate but linked to the national population health guidance), and

- could include recommendations around all three health behaviours to maximise positive health outcomes among New Zealand's under fives.

Limited evidence is available on sleep. It is an important component of the PA continuum and including material in guidance about sleep and health could provide important contextual material for parents and those working with children aged under five years.

5.1.6 Develop a co-ordinated, life course approach to national guidelines

The development of national population health advice on PA, sedentary behaviour and sleep would provide a clear framework for providing educative resources on PA and sedentary behaviour for those working or living with children aged under five years. This advice would complement the Active Movement resources rather than replace them. This approach is consistent with other countries (i.e., a set of national guidelines supported by a range of user-focused resources to promote the importance of PA for under fives and provide tips on how to do this effectively).

To support a life-course approach, a more coordinated framework could be provided to connect existing advice, Sport New Zealand's Physical Literacy Framework and new recommendations about PA and time being sedentary.

5.1.7 Undertake consultation

While *Allen + Clarke*'s review provides a strong starting point for the development of national population health advice on PA and sedentary behaviour for children aged under five years, it is appropriate that, given limited New Zealand-focused data, there should be further engagement with sector experts to consider the development of national population health advice. A similar process has been used by other countries in the development of their advice.

5.2. Active Movement resources

One of the main reasons for conducting the literature review and survey was to collect information that could be used to assess the current Active Movement resources and make recommendations about whether these resources require updating.

5.2.1. The current content is useful to stakeholders

Users indicated that there is a range of information that they find useful. This includes material currently included in the Active Movement resources as well as information that may only be briefly covered or not included at all. For example, users are interested in receiving advice on the kinds of PA that young children should be doing (i.e., information about type, intensity and context), information about how much PA children should be doing and how often (i.e., frequency and duration) and information about why PA is important. Table 5 (below) describes information stakeholders want compared with information currently in the Active Movement resources.

Table 5: Information sought by stakeholders and the content of Active Movement

Stakeholder identified information needs	Do the existing Active Movement resources provide this information?
Information on the kinds of PA that very young children should be doing	Some: provides advice on a range of FMS but does not generally describe intensity, type or context information
Information on how much PA that very young children should be doing	Not provided
Information about how often very young children should be active	Not provided
Information about why PA is important for very young children	High level statements provided
Ideas about how to encourage very young children to be active (including in specific settings such as early childhood education)	Yes
Resources in a range of languages including Te Reo (including in both written and oral language)	Yes

5.2.2. Not all stakeholder information needs are currently meet

Based on the existing Active Movement resources, there are some clear gaps between what the Active Movement resources currently deliver and the range of information that stakeholders want. The two main gaps appear to be:

1. Advice about the metrics associated with the type, content, intensity, duration and frequency of PA identified from the survey, and
2. Advice on sedentary behaviours and sleep identified from the literature review and assessment of other countries' guidance on PA for children aged under five years.

Content about the amount of PA and time spent being sedentary would be available if population health advice is developed for New Zealand's under fives. In the meantime, resource users could seek this information from other countries' guidance material.

A critical content gap within the current Active Movement resources is the lack of information about time spent being sedentary, health outcomes and sleep. The resources include some high-level statements about the positive outcomes of active movement (including how specific FMS, psychosocial and other skills contribute to wellbeing), but there is no mention of sedentary behaviour either in terms of appropriate levels or ways in which less active children can be encouraged to participate in more physical activity.

While the evidence base is still developing on the relationships between the three behaviours, there is sufficient evidence indicating that they are linked. As PA, sedentary behaviour and sleep are all important contributors to outcomes like obesity, it makes sense that any resources provided for those working with young children include information about all three health behaviours. This approach is consistent with that used in other countries' population health advice (i.e., they generally do not offer advice on PA without also discussing sedentary behaviours). Any PA-related publications or resources for those working with children under five years should therefore also include information about sedentary behaviour. Sleep could also be considered as this is also part of the activity continuum (i.e., from sleep to MVPA).

5.2.3. Additional content could be added to the current Active Movement resources

Guidance material or resources for those working and living with children aged under five years should include the following:

- Information on the importance of PA, sedentary behaviours and sleep for under fives
- Information on the type, context, intensity, duration and frequency of activity for infants, toddlers and pre-schoolers, and
- Advice on how to encourage young children to be physically active (including tips, tricks and ideas for activities for infants, toddlers and pre-schoolers).

Retaining the current resources without revision is an option; however, it may be detrimental to the Ministry's ability to positively impact childhood overweight and obesity.

5.2.4. The format of resources could be diversified

The Active Movement resources were developed and published more than 10 years ago. Since then, there have been significant changes to the ways in which people search for and receive information. Respondents identified that, while they are happy to continue to use hard-copy resources, they would use electronic or interactive apps and social media as a means through which to receive and disseminate advice and information. Preferred format options are now likely to reflect available technology that did not exist in 2003 and also perhaps the fact that English-language hard copy resources have been unavailable for some time. Offering the Active Movement resources in a range of formats could help to improve reach.

5.2.5. Active Movement resources are generally well known, but reach could be improved

Findings from the survey indicate that the Active Movement resources are generally well-known, well-used and fit for purpose in terms of supporting users to learn about PA and children aged under five years and providing ideas about encouraging children to be active. Almost one in five respondents have not heard of Active Movement (n=51 respondents, 19 percent of all respondents, including those who may not have fully completed the survey[4]) or have heard of them but not used the resources (n=41 respondents, 20 percent of respondents). A lack of access to hard copy resources, together with cessation of Active Movement advisors in some RSTs may have affected awareness. Given that they are generally well-supported, it is appropriate to consider retaining hard copies of these resources.

5.3. Options analysis

The Ministry of Health asked that an options analysis be prepared on whether the Active Movement resources are still appropriate and, if not, how they can be improved. This analysis includes consideration of the advantages and limitations of each option, potential costs, time involved and potential limitations. *Allen + Clarke* has recommended that national population health advice on PA, sedentary behaviour and sleep be developed and that resources covering a range of FMS be updated to include such advice. There are three options for achieving this, each with a different scope of work for the Ministry to consider. The options are set out in Table 6 (overleaf).

[4] That is, they dropped out of the survey once noting that they were unaware of the Active Movement resources.

Table 6: Options for consideration

	Guidelines on physical activity and sedentary behaviour for children aged under-five years	FMS Resources
Option 1: Enhanced status quo	Continue with national population health advice on PA and sedentary behaviour that excludes children aged under five years.	Republish existing Active Movement resources using same content and delivery options but include more online availability.
Option 2: Develop national advice for very young children supported by existing government-prepared FMS resources.	Develop national guidelines on PA and sedentary behaviour for children aged under five years following a similar process as used in other countries (i.e., literature review + the development of consensus statements).	Republish existing Active Movement resources using same content and delivery options but include greater access to material electronically (i.e., consider app development).
Option 3: Refresh the full framework of advice for children aged under five years	Develop national guidelines on PA and sedentary behaviour for children aged under five years following a similar process as used in other countries (i.e., literature review + the development of consensus statements).	Develop a new complement of resources that both align to the national population health advice on PA and sedentary behaviour.

Table 7 (overleaf) summarises the pros and cons associated with each option. In terms of maximum potential impact on childhood overweight and obesity, Option 3 appears to offer the most value and would respond best to needs identified by users of the current Active Movement resources.

Table 7: Options analysis

Option	Advantages	Limitations	Costs	Timing
Option 1: Enhanced status quo	Can be achieved relatively easily Cheapest and quickest to achieve *Also see costs and timing*	Does not reflect evidence-based recommendations on PA and sedentary behaviour Does not support a life course approach to promoting PA Does not respond to Active Movement users request for more detail on PA and under fives May miss opportunities to promote PA, reduce sedentariness and thereby positively impact on childhood overweight and obesity in NZ Does not take advantage of opportunities to collaborate with the developers of other resources	Likely to be the cheapest option (i.e., costs include publication costs for existing resources and distribution using existing networks as well as new online or app-development costs)	Can be implemented relatively swiftly compared to Options 2 and 3

Option	Advantages	Limitations	Costs	Timing
Option 2: Develop national advice for very young children supported by existing government-prepared FMS resources.	Better reflects evidence-based recommendations on PA and sedentary behaviour Supports a coordinated life course approach to promoting PA Enables opportunities to promote PA, reduce sedentary behaviour and thereby positively impact on childhood overweight and obesity in NZ Provides some of the information that stakeholders have requested in terms of dose-response information	Does not respond to Active Movement users' request for more detail on PA and under fives Does not take advantage of opportunities to collaborate with the developers of other resources	Likely to be the second cheapest option (i.e., costs include honoria for expert advisory group members, publication of guidelines, publication costs for existing resources and distribution using existing networks as well as new online or app-development costs)	Can be implemented more swiftly than Option 3 but will take a little longer than Option 1.
Option 3: Refresh the full framework of advice for children aged under five years	Better reflects reflect evidence-based recommendations on PA and sedentary behaviour Supports a coordinated life course approach to promoting PA Responds to Active Movement	*Most expensive and time consuming* *See costs and timing*	Likely to be the most costly option (i.e., costs include honoria for expert advisory group members, publication of guidelines, development costs for new resources including apps/online material although this could be offset should other	Will take the longest of the three options to implement; however, this may not be a substantial amount of time given that the data collection phase has been completed (i.e., this report). The development of new resources (including

Option	Advantages	Limitations	Costs	Timing
	users request for more detail on PA and under fives and formats Enables opportunities to promote PA, reduce sedentariness and thereby positively impact on childhood overweight and obesity in New Zealand Could be done in such a way as to take advantage of opportunities to collaborate with the developers of other popular and reduce duplication of resources		existing FMS resources be promoted).	testing) will result in significant additional time.

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KEY DEFINITIONS

Term	Definition
Adiposity	State of containing fat.
BMI	An indicator of excess body weight. A measure of weight adjusted by height that is used to classify individuals as underweight, overweight or obese. BMI is calculated by dividing your weight (kilograms) by height squared (m^2).
BMI z scores	One *z*-score is equivalent to a difference in BMI of 11 percent. *Referred to in Schmidt Morgen et al (2013).*
Curtailed sleep	Repeated low sleep duration reported over several years.
Dose-response relationship	The relationship between different doses of a variable and the level of response seen in another variable. For example, a one hour increase in time spent watching TV was associated with a 20 minute reduction in sleep time.
Fat free mass	Non-fat components of the human body (eg, skeletal, muscle, boned, water).
Fat free mass index	Measure of fat free mass adjusted for by height. Calculated by dividing fat free mass (kilogramme) by height squared (m^2).
Fat mass	Component of the human body that is composed of fat (adipose tissue) as opposed to fat free mass.
Fat mass index	Measure of fat mass adjusted for by height. Calculated by dividing fat mass (kilogramme) by height squared (m^2).
Fundamental movement skills	Basic movement skills such as throwing, kicking, running, jumping, hopping and catching. Precursor skills to more complex skills used in sports like passing a rugby ball, throwing a netball, jumping up for a basketball rebound.
Initially short sleepers	Characterised by short sleep at birth to aged one year relative to typical sleepers (difference of 1:52 hours), but only minor differences in sleep duration observed at aged four to five years and aged sizx to seven years (0:08–0:13 hours' difference). *Referred to in Magee et al (2014b).*
METs	Metabolic equivalents (METs) are a way of measuring how much energy people use, defined as the ratio of metabolic rate (and therefore the rate of energy consumption) during a specific physical activity to a reference metabolic rate. One MET is the energy a person needs to perform core functions for one minute at rest, such as breathing and pumping blood round the body. METs are used to classify the intensity of physical activity (light intensity 1.5 to 2.9 METs; moderate intensity is between three and 5.9 METs; vigorous intensity is six METs and over).
Motor skills	Movements (motions) carried out when the brain, nervous system and muscles work together. Motors skills are categorised as fine or gross. Fine motor skills use small muscles (eg, fingers, toes, and lips) and included movements such as picking up small objects, holding a pen). Bigger movements using large muscles (eg, arms and legs) are gross motor skills such as rolling over, sitting up, and walking.

Term	Definition
Obesity	Excessively high amounts of body fat (adipose tissue) in relation to lean body mass (eg, bone, muscle). Obesity is commonly separated into three classes: **Class 1** defined as a body mass index of 30 to 34.99 kg/m2 **Class 2** defined as a body mass index of 35 to 39.99 kg/m2, and **Class 3** defined as a body mass index of ≥40 kg/m2.
Odds ratio	The association of an exposure and a disease (relative risk) in a case-control study is measured by calculating the odds ratio (OR). OR is the ratio of the odds of exposure among the cases to the odds of exposure among the controls. Odds ratios are very similar to relative risk ratio if the condition/disease is rare.
Passive cycling	Cycling motion of legs imparted on one individual by another (eg, a parent moving their infants legs in a cycling motion).
Poor sleepers	Characterised by short sleep durations from birth to aged one year (9:54 hours), which gradually increased with age. These children had sleep durations that were 4:40 hours and 1:41 hours less than those of typical sleepers from birth to aged one year, and from aged two to three years. Differences less pronounced at aged four to five years and at aged six to seven years. This trajectory also had a very high rate of sleep problems compared with the other trajectories. *Referred to in Magee et al (2014b)*
Psychosocial health	Psychosocial health includes social, physical, and psychological health indicators like aggression, self-esteem, health-related quality of life, wellbeing, peer problems, social networks, family functioning.
Relative risk	The relative risk (also called the risk ratio) is the ratio of the risk of occurrence of a disease among exposed people to that among the unexposed. Used in assessing the likelihood that an association represents a causal relationship.
Short sleepers	Showed a gradual reduction in sleep duration from 13:25 hours from birth to aged one year to 9:44 hours at aged six to seven years. This pattern was similar to that of typical sleepers, but the amount of sleep duration was consistently lower. *Referred to in Magee et al (2014b)*
Typical sleeper	Characterised by a gradual decline in sleep duration from baseline (14:34 hours) to aged six to seven years (10:45 hours). The rate of this decline slowed with age. The amount and pattern of change over time are consistent with population data tracking sleep duration during childhood. *Referred to in Magee et al (2014b)*
Very young children	In this document refers to children aged 0 to 4.99 years.

APPENDIX A

DETAILED METHODOLOGY

The Ministry of Health contracted *Allen + Clarke* to undertake a review of existing FMS guidance/resource materials for children aged under five years (i.e., the Active Movement resources). This review will help to determine whether an update of the existing materials is needed and, if so, what the most appropriate way to update the information is. *Allen + Clarke* was contracted to develop a report that:

- summarises the available published literature on the benefits of FMS and PA (the primary scope), and sleep, sedentary behaviour and screen time
- reviews options for updating the existing advice, and
- makes recommendations on future directions for the Ministry's consideration.

An approach to identifying materials to include in the report was developed in collaboration with the Ministry. This approach included the establishment of search term parameters (i.e., inclusion and exclusion criteria), and a methodological approach utilising (1) literature and web searches and (2) a stakeholder survey. The details of this approach are discussed below.

Limitations and assumptions are discussed in the main body of this report.

Three work streams were undertaken to collect the evidence required to inform the analysis and recommendations. These were:

- PA work stream
- FMS work stream
- Sedentary behaviour and sleep work stream.

Within each work stream the following information was sought:

- National guidelines - Search for guidelines of PA from Australia, Canada, Ireland, New Zealand, the UK and the United States of America (2003 until 30 June 2015).
- Supporting materials underpinning the national guidance material - Search for supporting materials that explain the evidence underpinning existing national guidelines.
- Scholarly literature including systematic reviews (published since 2010):
    - Examining the link PA and FMS has with adiposity (and childhood overweight/obesity), bone/skeletal health, motor skills development, mental health, cognitive development, cardiovascular health, injury risk, sleep, and sedentary behaviour.
    - Examining the link sedentary behaviour and sleep has with adiposity (and childhood overweight/obesity) and PA, and mental health, cognitive development, cardiovascular health, injury risk, sleep, and sedentary behaviour.

A1 The literature search

A detailed terms of reference and search strategy was agreed with the Ministry of Health in June 2015. Once finalised, the agreed terms of reference was provided to the Ministry of Health's Library Services which conducted the agreed literature searches. The Ministry's Library Services searched ten literature databases and 19 government agency websites. The 10 databases search were:

- OVID Medline
- SPORTDiscus
- Scopus, PSYCHInfo
- Web of Science
- CINAHL
- National Institute for Health and Clinical Excellence
- Cochrane Library and the Cochrane Database of Systematic Reviews
- ERIC (Education Resources Information Centre), and
- Sport and Recreation Knowledge Library.

The 19 agency websites searched were:

- Sport New Zealand: www.sportnz.org.nz
- Ministry of Health: www.health.govz.nz
- Australian National Preventive Health Agency: www.anpha.gov.au
- Department of Health (Australia): www.health.gov.au
- Australian Institute of Sport: www.ausport.gov.au
- Health Canada: www.hc-sc.gc.ca
- Canada Sport for Life: www.canadiansportforlife.ca
- Department of Health (Ireland): www.dohc.ie
- Public Health Agency (Northern Ireland): www.publichealth.hscni.net
- British Heart Foundation National Centre: www.bhfactive.org.uk/home/index.html
- Sport England: www.sportengland.org and www.sportengland.org/media/388152/dh_128210.pdf
- Youth Sport Trust: www.youthsporttrust.org
- Sport Ireland: www.sportni.net
- Sport Scotland: www.sportscotland.org.uk
- Sport Wales: www.sport.wales
- Department of Health and Human Services (USA): www.hhs.gov
- Aspen Institute (USA): www.aspeninstitute.org
- Office of Disease Prevention and Health Promotion (USA): www.odphp.osophs.dhhs.gov
- Sport Ireland: www.sportni.net
- World Health Organization: www.who.int
- Secretariat for the Pacific Community: www.spc.int, and
- The Centers for Disease Control and Prevention (USA): www.cdc.gov.

Search Terms

To manage the number of potential returns, the following search terms were used to identify studies focused on children aged under five: infant, toddler and pre-schooler.

Selection Process

Once the list of returned abstracts and citations was received, *Allen + Clarke* conducted a comprehensive selection process. The selection process involved:

- an initial screen of the title and abstract of each article to determine relevance
- request of the full text article if the article appeared relevant and appeared to meet the inclusion criteria (as set out in the literature review terms of reference)
- assessment of the full text of each potentially relevant article (or otherwise)
- review of each study included in each of the systematic reviews to determine relevancy as most covered age ranges extending beyond up to aged five years
- a bibliography check was conducted on all systematic review identified through the search process and on all articles included for review
- review of the returned webpages regarding guideline document and identification of applicable guidelines.

The initial search strategy returned 736 records. An initial review revealed a very large number of irrelevant articles returned because of an issue with false drops (for example, caused by the use of the word 'play'). All obviously irrelevant articles (i.e., such as those not related at all to children or PA and health outcomes) were removed. From this initial screening step, 736 abstracts remained. After duplications were removed, 621 individual articles remained to be checked for inclusion (see Figure 1). The number of articles per topics is described in Table A (overleaf).

Figure 1 Identification, screening/eligibility, and inclusion of articles

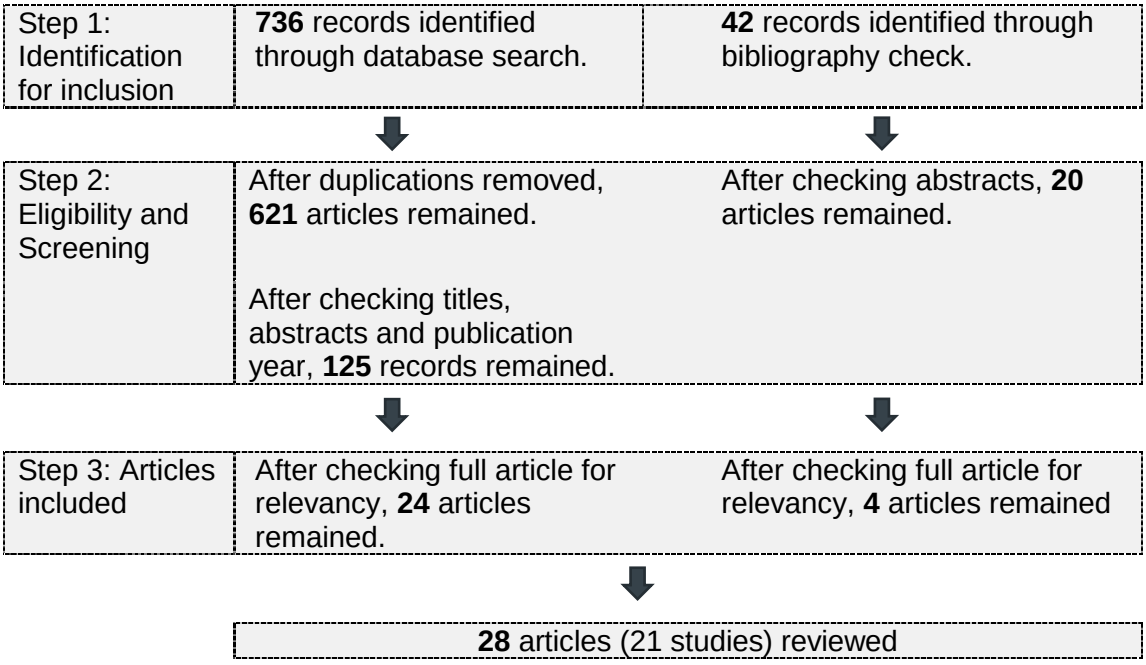


Table A: Number of studies discussed per review and health topic

Number of…	Health Behaviour			Total number of unique studies (total number of articles)
	PA	Sedentary Behaviour	Sleep	
Unique studies				
In the review	11	7	6	21‡ (28)
New Zealand-based	0	0	1	1
Uniques studies per health outcome				
Adiposity/ obesity	7	4	4	-
Bone/skeletal health	0	0	0	-
Psychosocial health	1	2	4	-
Cognitive abilities	2	1	1	-
Cardio-metabolic health	0	0	0	-
Risk/ Injury	0	0	0	-
PA/Motor Skills	6	0	0	-
Sedentary behaviour	3	NA	1	-
Sleep	0	2	NA	-

NA: not applicable
‡ This is less than summing PA, sedentary behaviour and sleep articles (32 articles) because some articles measured more than one health behaviour (PA, sedentary behaviour and sleep).

A2 The stakeholder survey

The stakeholder survey aimed to collect information about users' experiences working with the Active Movement resources. The best mechanism for receiving opinion-based input from such a broad stakeholder group was considered a one-off online survey as the required information is not available from any other source at this time.

A2.1 Survey design

Firstly a detailed terms of reference was developed by *Allen + Clarke* and agreed with the Ministry of Health. Following this, a survey logic and survey tool was created and tested in hard-copy and online to confirm the question and survey logic was accurate. Following confirmation of the logic of the survey tool, it was entered on to the Survey Monkey website.

A2.2 Participant invitation

The Active Movement resources are used by a wide range of stakeholders including parents, early childhood educators, public health practitioners, academics, health professionals, Māori health providers, Pacific health providers, national sports organisations, and RSTs.

Stakeholders were identified through discussions with the Ministry of Health and Sport NZ to identify broad categories of potential respondents (i.e., early childhood educators, sports organisations, health providers, parents and health professionals working with young children). *Allen + Clarke*, the Ministry of Health and Sport NZ then worked to identify organisations and individuals within these categories.

Seventy-eight stakeholders (including organisations and individuals) were identified. These are described in Table B (overleaf). Participation through a number of organisations was open (i.e., the survey link was sent to organisations with a request for them to share the survey broadly within their networks). The range of participation approaches were also provided (again, listed in Table B overleaf).

Table B: Invitations to participate in the survey by category of invitee

Category of respondent	Number of organisations invited	Invitation approach	Number of respondents
Early childhood educators	22	Requested distribution through invitee's network	156
Other educators	1	Emailed to a named individual	16
Academics/researchers	5	Emailed to named individuals	10
Providers of PA opportunities for children aged under five years	2	Requested distribution through invitee's network	-
National Sports Organisations	6	Emailed to a named individual	1
RSTs	18	Emailed to a named individual	14
Health-related NGOs	1	Requested distribution through invitee's network OR emailed to a named individual OR advised through sector-focused newsletter	-
Public Health Units	12	Emailed to a named individual	9
Parents	5	Requested distribution through invitee's network	9
Health practitioners	5	Requested distribution through invitee's network OR emailed to a named individual OR advised through sector-focused newsletter	40
Government agency	1	Emailed to a named individual	-

We do not know the total number of potential respondents given the invitation mechanisms employed. As such, it is not possible to determine a response rate because we are unaware of the total number of potential respondents who may have seen the survey invitation. We consider that the survey results have a good degree of generalisability in terms of potential users of the Active Movement resources given the number of respondents and breadth of respondent demographics.

A2.3 Analysis

The survey was open for four weeks (from 4 August to 28 August 2015).

Survey results were analysed and described using descriptive statistics (i.e., simple percentage comparisons were done). This was done using tools on the Survey Monkey website. Statistics were calculated for the entire sample, for specific sub-group analysis (eg, work category), and three respondent profiles:

1. Users of Active Movement resources (i.e., those who had heard of the Active Movement resources AND who had used them)
2. Non-users who are aware of the resources (i.e., those who had heard of the Active Movement resources AND who had not used them), and
3. Non-users (i.e., those who had not heard of the Active Movement resources).

Analysis was conducted on all relevant questions for each group.

No work was carried out to validate the results.

APPENDIX B

LITERATURE REVIEW

Appendix B provides a narrative review of academic literature published from 2011 to June 2015 on three health behaviours (PA, sedentary behaviour and sleep habits) and their relationship with health outcomes in children from birth to aged five years (i.e., 0 to 4 year olds inclusive). A methodology description is provided in Appendix A.

Detailed findings from the 21 published studies (28 articles) are presented.

The findings add to the conclusions drawn from two recent systematic reviews which informed the development of national population recommendations and advice on PA and sedentary behaviour guidelines in Canada and the UK. These were a systematic review of:

1. PA and health in children aged under five years (Timmons et al 2012), and
2. sedentary behaviour and health in children aged under five years (Le Blanc et al 2012).

No similar review on sleep and health was found.

Timmons et al (2012) and Le Blanc et al (2012) reviewed articles published up to May 2011. To add to this body of evidence, we reviewed articles published in 2011 and onwards. No articles were duplicated between our review and those included in Timmons and Le Blanc. For comparison purposes, a brief summary of the findings from the two systematic reviews are presented (in text boxes) throughout this Appendix.

B1 Structure of Appendix B

Appendix B contains the following five sections:

- B2 PA and health outcomes, which examines the relationship between PA and adiposity, psychosocial health, cognitive ability, motor skills and sedentary behaviour.
- B3 Sedentary behaviour and health outcomes, which examines the relationship between sedentary behaviour and adiposity, psychosocial health, cognitive ability, and sleep.
- B4 Sleep and health outcomes, which examines the relationship between sleep and adiposity, psychosocial health, cognitive ability and sedentary behaviour.
- B5 A summary of the discussion and limitations associated with the literature review.
- B6 Tables summarising study characteristics, key findings and covariates per study.

B2 Academic literature on PA and health outcomes

PA is defined as any bodily movement generated by skeletal muscles that results in energy expenditure above resting levels (Caspersen et al 1985). Given the broad age range and development stages covered within the under fives age group, reviewed literature uses different age-appropriate measures of PA. Measures included detailed movement patterns (eg, antigravity movements during infancy), FMS/gross motor skills (like sitting or walking), and intensity-based PA measures like time spent in MVPA. For infants, parental reports and direct observations were used. For toddlers and pre-schoolers, researchers used a mix of methods like parental reports and objective measures like pedometers and accelerometers.

B2.1 Number of studies reviewed for PA

Eleven studies (discussed in 13 articles) were reviewed. The articles covered:

- adiposity (six studies, seven articles)
- PA/motor skills (six studies)
- psychosocial health (one study)
- cognitive abilities (two studies), and
- sedentary behaviour (two studies).

No New Zealand studies or articles on cardiovascular health, risk/injury, or sleep outcomes were found.

Indicators of PA and FMS varied across studies. For infants, movement time (Sijtsma et al 2013) and age at which motor milestones (like sitting and walking) were achieved (Schmidt Morgen et al 2013; Benjamin Neelon et al 2012) were measured using subjective measures (i.e., parental reports). For pre-schoolers, MPA and VPA (Annesi et al 2013b), step counts (Bellows et al 2013) and motor skill level (Bonvin et al 2013) were measured using objective tools including accelerometers, pedometers and expert observer assessments respectively.

A summary of findings is included in Tables D and E (pages 87-90).

The findings from the 11 reviewed studies build on the findings from the 18 studies systematically reviewed by Timmons et al (2012).

B2.2 PA and obesity/adiposity

Seven studies were reviewed by *Allen + Clarke*. This included three cohort studies (Benjamin Neelon et al 2012; Schmidt Morgen et al 2013; Sijtsma et al 2013) and one RCT (De Vries et al 2015) focused on infants. A further three RCTs focused on pre-schoolers (Annesi et al 2013b; Bonvin et al 2013; Bellows et al 2013).

Infants

Mixed findings emerged for FMS. Schmidt Morgen et al's 2013 cohort study of 25,000 young children found that the age at which key milestones (eg, sitting,

crawling and walking) is achieved was not associated with increased risk of being overweight at aged seven years. A weak association was observed between later achievement of sitting (p=-0.023, 95%CI=-0.029; -0.017) and walking (p=-0.005, 95%CI=-0.015) and lower BMI z-score at aged seven years.

A smaller cohort of 741 children studied by Benjamin Neelon et al 2012 also found no association between achieving key milestones and BMI z-scores. Associations were seen with skinfold. Later attainment of rolling over and sitting up (after aged six months compared with before six months of age) was associated with slightly higher skinfold-determined central adiposity at aged three years (rolling over: +0.04mm; sitting up: +0.02mm, respectively). Later aged of walking (defined as being older than aged 15 months compared to younger than aged 12 months) was linked to higher overall adiposity (+0.98mm) as measured by sum of skinfold measures. Age of crawling was not associated with later adiposity.

Sijtsma et al's 2013 study of 1,200 infants found unrestricted movement time was favourably associated with change in weight indices. Nine-month-old infants who spent five or more hours per day in unrestricted movement achieved higher decreases in weight-for-height z-scores (-0.11, $p < 0.01$) and weight-for-age z-scores (-0.08, $p < 0.05$) over a 15 month timeframe (from aged nine months to aged 24 months).

One RCT (De Vries et al 2014) of 143 infants showed a positive intervention impact on some adiposity indicators (including skinfold) but not others (including BMI and %BF). Infants whose parents received age-appropriate play and movement advice from nurses during the baby's first year of life had lower sum of skinfolds (-2.8mm) and abdominal skinfold (-1.1mm) at aged 2.5 years. Larger differences in sum of skinfold were seen for girls (-3.6mm) and overweight children (-7.0mm) in the intervention group. No link with BMI was found. The differences noted occurred without between-group differences in accelerometer-determined PA or motor skill level.

Pre-schoolers

Based solely on RCT evidence, only one (out of three) interventions impacted BMI favourably. All three interventions were delivered in a pre-school or childcare setting. Intervention approaches and strategies, intervention duration and PA and FMS measures differed between studies.

The successful intervention, Start for Life, was tested across 19 classrooms in seven schools with a study cohort of 1,154 predominantly African American (86 percent) pre-schoolers (Annesi et al 2013b). The intervention involved 30 minutes of highly structured PA delivered in a pre-school setting. After nine months, a reduction in BMI (-0.14BMI units) was achieved by the intervention children compared with the usual PA practice undertaken by the control group. Larger reductions were seen for overweight and obese children (-0.51 BMI units).

In contrast, the Mighty Moves and 'Youp'là Bouge' interventions had no impact on BMI (Bellows et al 2013; Bonvin et al 2013) or BMI z-scores (Bellows et al 2013) immediately post intervention.

Mighty Moves was an 18-week structured activity programme delivered through four 15-20 minute sessions per week and focused on FMS. 'Youp'là Bouge', a government-led initiative in Switzerland, consisted of environmental and individual-level behavioural change strategies. Strategies were either recommended or mandatory to implement and therefore not always implemented consistently across the 29 intervention centres. Mandatory changes included environment changes and staff training. Recommended strategies included daily PA session, structured PA curriculum, and parent involvement. Compared with the Start for Life intervention, these unsuccessful initiatives appeared to have one or more of the following short-comings: the initiative was less intensive, shorter in duration, focused on FMS (rather than MVPA), and intervention components were not mandatory to implement.

Summary

For infants, higher levels of PA appears to be associated with or impact on later adiposity. Findings for motor skills were mixed. Associations were found for SF measure but not for BMI or %BF. Many of the associations were small in size, but larger intervention effects were seen for overweight individuals. For pre-schoolers, interventions targeting PA or FMS had limited success on changing adiposity outcomes (one out of three interventions exerted an effect). These findings are consistent with Timmons et al (2012).

Timmons et al's 2012 findings

- For infants, mixed cohort findings emerged. One study showed more active infants had lower tricep skinfold thickness (after adjusting for total fat) and two other studies found no link between activity at aged six months and %BF or total body fat in later life, at aged 12 months or at aged eight years.
- Only one out of four RCTs showed a positive intervention effect. For pre-schoolers, dance classes did not impact obesity prevalence or weight, but girls (not boys) in the dance group had reduced risk of increased BMI. Two interventions had no effect on BMI. The third intervention had no impact on lean muscle mass or fat mass.
- Cohort evidence linked PA with smaller gains in BMI and better adiposity indicators (%BF, smaller gains in BMI, or skinfold thickness) in later childhood (up to aged eight years). One study found no effect on BMI or % BF.
- An inverse dose-response between PA and adiposity (BMI and SF). Pre-schoolers with higher PA had more favourable adiposity levels in later life (up to seven years).
- The authors concluded that higher and/or increased PA was associated with improved adiposity outcomes for infants and toddlers.

B2.3 PA and bone and skeletal health

No studies reviewed by *Allen + Clarke* examined the link between PA and bone/skeletal health.

Timmons et al's 2012 findings

- Only two RCTs examined the impact of PA on bone/skeletal health indicators.
- For infants and toddlers, a programme focusing on gross motor skill activity (instead of fine motor skill activity) had no effect on bone mineral content at aged 18 months.
- For pre-schoolers, a motor skill intervention was associated with an increase in tibia circumference post intervention and 12 months later. No impact was seen for other skeletal health indicators including total body bone mineral content, arm bone mineral content, leg bone mineral content, total body bone area, arm bone area, or leg bone area.
- From these studies, the authors concluded that increased or higher PA was positively associated with bone and skeletal health in toddlers.

B2.4 PA and psychosocial health

Pre-schoolers

One RCT (Bonvin et al 2013) focused on pre-schoolers was identified. After aged nine months, the government-led Youp'là Bouge initiative in Switzerland did not improve pre-schooler's quality of life (eg, physical, emotional, social, and school functioning) as assessed by the PedsQoL Questionnaire.

Summary

Given the findings are based on one RCT study, drawing definitive conclusions about intervention effects on psychosocial health indicators is not possible.

Timmons et al's 2012 findings

- In contrast to the above findings, Timmons et al (2012) found cohort and RCT evidence that indicated that PA positively impacts psychosocial health. Based on cohort evidence, active pre-schoolers were rated as more outgoing and less socially withdrawn by teachers. Based on RCT evidence, infants who participated in daily passive cycling for two months had higher social development scores than controls. Pre-schoolers who participated in a dance programme improved their social competence and externalising behaviours (as reported by parents and teachers) to a greater extent when compared with the control children.
- From these studies, the authors concluded that increased or higher physical activity improved psychosocial health indicators in pre-schoolers.

B2.5 PA and cognitive abilities

Findings are based on two cohort studies. One focused on infants (Hitzert et al 2014) and one focused on toddlers (Wang et al 2012).

Indicators of PA and FMS included infants movement patterns (Hitzert et al 2014) and motor skill ability. A composite score of motor skill ability was determined from a toddler's ability to walk, throw, stack blocks and turn pages of a book (Wang et al 2012).

Infants

Hitzert et al's study of 74 infants found significant associations between movement patterns and cognition, but these were not always in the expected direction of normal age-appropriate movement patterns that would lead to better health outcomes. Some age-appropriate motor movements like the presence of anti-gravity, midline leg and manipulation movements were associated with lower intelligence, attention, and visual-motor integration and poorer attention when aged five years. In contrast, normal variable finger postures was associated with better cognition. Abnormal movement pattern (i.e., monotonous concurrent motor repertoire) was associated with more behavioural problems. These findings should be interpreted with caution given the small sample size and very wide confidence intervals observed.

Toddlers

Wang et al's 2012 cohort study of 62,000 toddlers found motor skill level (as measured by a composite score of four tasks: walking, turning pages, stacking blocks and throw) at aged 1.5 years was favourably associated with communication skills like comprehension, speech, and carrying out instructions correctly at aged three years (cross-lagged coefficient = 0.38). Both motor and communication skills were subjectively assessed by parents through the use of the Ages and Stages Questionnaire.

Summary

Few studies have looked at the impact/association of PA on psychosocial health. Evidence from one large cohort study suggests a positive association between motor skills and communication skills during the toddler years. This finding is consistent with Timmons et al (2012).

Timmons et al's 2012 findings

- PA was linked to better communication, but among infants and based on experimental evidence. For infants, daily passive cycling for two months was positively associated with increased communication in the form of facial expressions, sounds, vocalisations, and babble.
- The authors concluded that increased or higher PA was positively associated with cognitive development for infants.

B2.6 PA and cardio-metabolic health

No studies examining the link between PA and cardio-metabolic health were reviewed by *Allen + Clarke* were found.

Timmons et al's 2012 findings

- Cohort evidence from two studies showed PA was associated with improved cardio-metabolic profile. Findings differed for boys and girls. Retaining higher levels of parent-reported PA was linked to improved total cholesterol and HDL/total cholesterol ratio for girls and triglycerides levels for boys. Another study found boys who did 56 minutes of accelerometer–determined MVPA exhibited a healthier metabolic status than those who did less. A similar, but non-significant, trend was seen for girls who did more than 42 minutes of MVPA. No link was seen for several other cardio-metabolic health indices (eg, insulin resistance or leptin).
- The authors concluded that increased or higher PA improved cardio-metabolic health indicators in pre-schoolers.

B2.7 PA and motor skill development

Six studies examined the impact of PA on FMS (and vice versa). Three studies focused on infants. Study designs included one cohort study (Hitzert et al 2014), one quasi-experimental study (Jorge et al 2013) and one RCT (De Vries et al 2014). The remaining three studies focused on pre-schoolers and were all experimental. One was a quasi-experimental study (Zhou et al 2014) and two were RCTs (Bonvin et al 2013; Bellows et al 2013). Reviewing the impact of PA interventions on PA outcomes and motor skills interventions on motor skill outcomes was not in scope; however, results are presented if interventions included a mixed of PA and FMS strategies.

Infants

Based on a cohort of 74 infants (Hitzert et al 2014), many age-appropriate movement patterns at aged three months (like antigravity movements and midline leg movements) were not associated with proficiency of everyday motor skills (like ball skills) at aged five years. Monotonous concurrent motor repertoire (abnormal movement) was associated with better ball skills ($\beta = 0.31$).

Similarly, two experimental studies did not find motor skills and PA to be related. One was an education-based intervention (n=143 infants and parents) in which nurses delivered advice to parents to promote recommended daily PA and motor development stimulation during an infant's first year of life had no effect on gross motor skills or accelerometer-determined PA at aged 2.5 years when compared with standard care (De Vries et al 2014). The second intervention (n=12 infants) consisted of weekly swimming lessons over four months. Swimming did not enhance

motor development beyond improvements seen in the control group (Jorge et al 2013). The experimental group improved its mean percentile rank[5]. This difference may be an artefact of converting raw scores to percentiles.

Pre-schoolers

Based solely on experimental studies, one (out of three) interventions reported a favourable intervention effect. All three interventions were delivered in a pre-school. Intervention approaches and strategies, intervention duration, and PA or FMS measures differed between studies.

The successful intervention was tested using a convenience sample of two childcare facilities (Zhou et al 2014). It consisted of a comprehensive, policy-driven, multifaceted intervention aimed at promoting physical fitness. After 12 months, pre-schoolers improved on a range of motor skill-related fitness outcomes such as a 20-metre agility run, tennis ball throwing, balance beam walk and 20-metre crawl.

In contrast, the 18 week Mighty Moves and nine month 'Youp'là Bouge' interventions had no impact on weekly pedometer steps (Bellows et al 2013) or motor skills (Bonvin et al 2013). Compared with the successful initiative, the two unsuccessful initiatives appeared to have one or more of the following short-comings: the initiative was less intensive and of short duration, intervention components were not mandatory to implement, and the focus of the intervention was less aligned with the outcomes measures (in the successful intervention skills taught reflected the outcome measured).

Summary

For infants, the limited evidence and small smaple sizes of studies prevents definitive conclusions. For pre-schoolers, cohort evidence was non-existent and intervention effects were limited. This finding is consistent with Timmons et al (2012).

Timmons et al's 2012 findings

- For infants, one experimental study (out of three) showed an intervention effect. Daily passive cycling for two months during infancy improved a range of age-appropriate motor skills including body control, balance, and grasping and hand-eye coordination.
- For pre-schoolers, two interventions achieved a positive impact. Bi-weekly dance classes improved motor development scores and a nursery-based PA programme consisting of three 30 minute PA sessions per week (over 24 weeks) increased FMS but not habitual PA. A PA intervention of three 30 minute PA sessions per week (over 24 weeks) improved fundamental movement scores (without significant change in habitual PA).

- The authors concluded that increased or higher PA improved motor skills

[5] A normative sample of 2,202 Canadian infants from birth to 18 months.

development in infants and pre-schoolers.

B2.8 PA and sedentary behaviour

Findings are based on two RCTs presented across three articles (Annesi et al 2013a; Annesi et al 2013b; O'Dwyer et al 2013). Both studies tested interventions delivered through a pre-school setting, used accelerometers to measure PA and sedentary time, and focused on older pre-schoolers. Indicators of PA assessed were accelerometer-determined MPA and VPA (Annesi et al 2013b) and daily PA (O'Dwyer et al 2013).

Pre-schoolers

Time spent being sedentary remained unchanged in both PA intervention, irrespective of whether PA improvements were achieved (Annesi et al 2013b) or not (O'Dwyer et al 2013). After eight weeks (Annesi et al 2013a) and nine months (Annesi et al 2013b) of the Start for Life initiative (described previously), time (during a pre-school day) in MVPA and VPA increased but time spent being sedentary remained unchanged for the 1,154 pre-schoolers in the study. A six-week play intervention (one 60 minute session per week) for 240 pre-schoolers had no impact on daily PA or sedentary levels (O'Dwyer et al 2013).

Summary

No evidence is available for the infant and toddler populations. For pre-schoolers, limited evidence is available. Based on RCT evidence, interventions were ineffective in changing accelerometer-determine sedentary behaviours.

Timmons et al (2012) did not assess the association between PA and sedentary behaviour.

B2.9 PA and sleep

No articles were found examining the impact of PA on sleep.

Timmons et al (2012) did not assess the association between PA and sleep.

B3 Academic literature on sedentary behaviour and health outcomes

Sedentary behaviour is defined "as any waking behaviour characterised by an energy expenditure ≤1.5 metabolic equivalents (METs) while in a sitting or reclining posture" (excluding sleep) (Sedentary Behaviour Research Network 2012). This is different to the concept of being 'inactive'. Inactive refers to individuals who do not meet recommended PA levels. Time spent watching TV or in front of a screen is often used as a proxy measure for sedentary behaviour.

B3.1 Number of articles reviewed for sedentary behviour

Initially, the review's focus was narrowed to screen-based sedentary behaviours. Due to the limited number of studies emerging, all studies measuring any form of sedentary behaviour were then included. This resulted in the inclusion of one additional study measuring sitting time in infants.

Seven studies (eight articles) covering the following health outcomes are reviewed:

- adiposity (four studies)
- psychosocial health (two studies)
- sleep (two studies), and
- cognitive abilities (one study).

No articles met the inclusion criteria for motor skills, cardiovascular health, or risk/injury.

No published New Zealand research was found (although the Le Blanc et al (2012) review included one New Zealand article).

All studies assessed sedentary behaviour subjectively through use of parental reports. Indicators for pre-schoolers included parental report of their child's time spent watching TV, using e-game/computers, or total media use either daily or over an entire week. For infants, one study assessed the use of baby seats (eg, car seats) as an indicator of non-movement time.

A summary of findings is included in Tables F and G (pages 91-92).

The findings from the seven reviewed studies build on the findings from the 21 articles systematically reviewed by Le Blanc et al (2012).

B3.2 Sedentary behaviour and adiposity/obesity

Findings are based on four studies including two cohort studies, one of which focused on infants (Sijtsma et al 2013) and one which focused on toddlers (Fuller-Tyszkiewicz et al 2012). A further two RCTs focused on pre-schoolers (Yilmaz et al 2015; Birken et al 2012).

All studies assessed indicators of sedentary behaviour subjectively through parental reports. Indicators included time spent in baby seats (Sijtsma et al 2013) and time spent watching TV (Fuller- Tyszkiewicz et al 2012) or using electronic media (TV, computer, internet) (Yilmaz et al 2015; Birken et al 2012).

Infants

A study of 1,200 infants (Sijtsma et al 2013) showed infants who 'never' used baby seats (eg, a car seat or child seat) achieved a greater decline in weight-for-height z-score (mean±SD = -0.34 ±0.63, $p < 0.05$) and weight-for-age z-score (mean±SD = -0.30 ±0.82, $p < 0.05$) over a 15 month timeframe (from aged nine to 24 months), compared with infants who used baby seats. Contrary to this, sitting for one hour or

more in a baby seat was associated with a higher decline in waist-circumference-for-age (mean±SD = -0.22 ±1.04, $p < 0.05$). There was a lack of variability in responses as few infants never used or spent more than one hour in a baby seat. The authors could not conclude whether and how time in baby seats affects growth patterns. They noted that using baby seats for less than two hours per day has no known adverse effect on the development of weight in very young children.

Toddlers

Based on a cohort of 4,000 toddlers (Fuller-Tyszkiewicz et al 2012), those who watch more weekly TV at aged two years had higher BMI as a pre-schooler at aged four years and during childhood at aged six years (correlation = 0.11 to 0.12). This TV-BMI association was found to be bi-directional. Higher BMI also predicted higher TV viewing time in later childhood. Looking at mediators and confounders, daily food intake (as reported by parents) did not mediate BMI-TV viewing. PA was not accounted for in the analysis.

Pre-schoolers

Two interventions targeting a reduction in TV viewing had no impact on pre-schoolers BMI z-scores directly post intervention (Yilmaz et al 2015) or one year later (Birken et al 2012), despite reductions in screen time reported in one study (Yilmaz et al 2015). The interventions tested were an eight-week family-based behaviour change intervention for 160 families (Yilmaz et al 2015) and a brief ten minute behavioural intervention delivered to parents of 412 pre-schoolers at their child's annual health check when the child was aged three years (Birken et al 2012).

Summary

Few studies exist for each infants, toddlers and pre-schoolers. For toddlers based on a single, but large, cohort study, the TV viewing-BMI relationship was found to be bi-directional. Toddlers who watch more TV had higher BMI values in later childhood and toddlers with higher BMI spent more time watching TV in later childhood. For pre-schoolers, interventions targeting reduced TV viewing had no impact on BMI z-scores. These findings are consistent with some of Le Blanc et al's (2012) findings.

Le Blanc et al's 2012 findings

- Interventions targeting a reduction in TV viewing had no impact on pre-schoolers BMI.
- Dose-response relationships exist based on cohort evidence, including one New Zealand-based study. For pre-schoolers, cohort evidence showed greater TV exposure was linked to higher BMI and skinfolds at aged six and 11 years. Pre-schoolers who watched at least three hours of TV had greater increases in BMI and skinfold measures at aged 11 years compared to those who watch less than 1.75 hour per day.
- Examining TV content (not viewing time), each additional hour of viewing commercial TV (with advertisements), was associated with an increase of…

…0.11 BMI z scores among a sample of newborns to children aged six years. No association was seen for non-commercial TV. The authors concluded that it is the content of the television (advertising) and not the sedentary behaviour that is the cause of the increase in BMI.

- Not all studies found an association. One cohort study found no association between TV exposure for more than two hours a day at aged three years and overweight status at 4.5 years old or change in BMI from aged three years to 4.5 years.
- The New Zealand-based study (Blair et al 2007) of 871 European children reported that accelerometer-determined sedentary time and parent reported TV viewing time were independently associated with %BF at aged seven years. Children who watched one to three hours or more than three hours had more %BF (2.5 percent and 5.2 percent respectively), compared with children who watched less than one hour of TV per day. For each additional hour of accelerometer-determined sedentary activity (during waking hours) children had 0.8 percent more body fat. These findings were adjusted for some known covariates of obesity (eg, socioeconomic status, maternal BMI), but not others (eg, nutritional confounders).
- Le Blanc et al concluded that evidence suggests increased TV viewing is associated with unfavourable measures of adiposity.

B3.3 Sedentary behaviour and psychosocial health

Findings are based on two studies: one cohort study of 3,600 pre-schoolers (Hinkley et al 2014) and one RCT (Yilmaz et al 2015). Sedentary behaviour was measured subjectively through parental reports of time spent using electronic media including TV, computer and the internet (Hinkley et al 2014, Yilmaz et al 2015). Indicators of psychosocial health were aggressive and delinquent behaviours (Yilmaz et al 2015) and well-being (Hinkley et al 2014).

Pre-schoolers

Hinkley et al (2014) found media use at aged four years was associated with poorer outcomes at aged six years for some psychosocial variables (emotional problems, family functioning) but not others (self-esteem, emotional wellbeing, social networks). Associations differed by gender and type of sedentary behaviour. For example:

- Higher weekday e-game/computer use was associated with increased likelihood of being at risk for emotional problems (eg, worried often, unhappy, and depressed) for girls only (OR: 2.0).
- Higher weekday TV viewing was associated with increased likelihood of being at risk for poor family functioning (eg, getting on with family, felt fine at home) for boys (OR: 1.2) and girls (OR: 1.3).
- Higher weekend TV viewing was associated with increased likelihood of being at risk for poor family functioning for girls (OR: 1.3).

The RCT by Yilmaz et al (2015), which included 412 participating families, found an eight-week, family-based, education programme targeting reduced screen time had a positive impact on children's psychological health. Nine months after the intervention, and compared to the control group, intervention children had lower levels of parent-reported media use, aggressiveness (mean score = 3.35 vs 3.85, p=0.001) and delinquent behaviours (3.45 vs 3.85, p=0.006).

Summary

Based on the large cohort study and one RCT, evidence suggests media use is negatively associated with some indicators of psychosocial health, but not all and that family based interventions targeting reduced screen time can favourably change parent-reported aggressive and delinquent behaviours among pre-schoolers. These findings are consistent with Le Blanc et al (2012)

Le Blanc et al's 2012 findings

- Media use negatively impacts psychosocial health indicators.
- Cohort evidence showed, for toddlers, higher TV exposure was linked to lower pro-social behaviours and higher risk of aggressive behaviours, externalising problems and victimisation like name calling and being hit/pushed.
- Several dose-response relationships were found.
  - For toddlers, victimisation score increased by 10 percent for each additional hour of TV viewed.
  - For pre-schoolers, each additional hour of TV viewing between 29 and 53 months was associated with a six percent increase in victimisation.
  - Also, each additional hour of TV viewing at aged four years was associated with increased odds of being bullied between the ages of six to 11 years.
  - Among newborns to children aged six years, each additional hour of violent programming boys watched at aged two to four years was linked to increased odds of antisocial behaviour when aged seven to nine years. No effect was seen for nonviolent and educational programming.
- The authors concluded that evidence suggests increased TV viewing is associated with unfavourable measures of psychosocial health. A dose–response relationship was evident between increased time spent watching TV and decreased cognitive development.

B.3.4 Sedentary behaviour and cognitive abilities

One quasi-experimental study (Lillard and Peterson 2011) was reviewed. This study examined the impact of TV content (not TV viewing time) on executive function among 60 pre-schoolers. Two indicators of executive functioning were assessed:

1. the delay of gratification score, and
2. an overall executive functioning score.

The latter score was based on results from three tasks:

- Tower of Hanoi (a mathematical puzzle based on stacking circles with decreasing radius on a stick)
- The game: head, toes, knees, and shoulder, and
- backward digit (a cognitive memory test based on remembering the order of numbers and repeating them in reverse).

Watching fast-paced cartoons for nine minutes appeared to impair executive functioning, at least temporarily, when compared with watching an educational cartoon or drawing for nine minutes. Children watching fast-paced cartoons achieved a lower executive functioning score compared with drawing group and a lower delay of gratification score (i.e., they could not wait as long for the treat) compared with educational TV and drawing groups. Fast-paced television group waited less time to receive gratification. The educational TV and drawing groups did not differ on either score. Effects of repetitive and long-term exposure requires further investigation.

Summary

Type of TV content appears to decrease cognitive abilities temporarily among pre-schoolers. These findings are consistent with Le Blanc et al's 2012 findings.

Le Blanc et al's 2012 findings

- Most, but not all, cohort studies found TV was linked with poorer cognitive outcomes among infants and toddlers.
- Several dose-response relationships appeared:
  - For infants, TV viewing was associated with increased risk of language delay.
  - For toddlers, each additional hour of TV was linked to seven percent decrease in classroom engagement and six percent decrease maths achievement at aged 10 years.
- Studies including infants and toddlers found each additional hour of TV exposure was linked to less vocalisation, increased attention problems, and poorer recognition, comprehension and memory scores.
- The authors concluded that evidence suggests increased TV viewing is associated with unfavourable measures of cognitive development. A dose-response relationship was evident between increased time spent watching TV and decreased cognitive development.

B3.5 Sedentary behaviour and sleep

Findings are based on two cohort studies of 1,200 toddlers (Marinelli et al 2014) and 3,400 pre-schoolers (Magee et al 2014c).

Both studies assessed sedentary behaviour and sleep habits subjectively through parental reports. Indicators of sedentary behaviour included time spent watching TV

daily (Magee et al 2014c; Marinelli et al 2014), using computers (Magee et al 2014c) and total media use time (Magee et al 2014c). Total daily sleep time, including naps (Magee et al 2014c; Marinelli et al 2014) was assessed by a single question (Marinelli et al 2014) or 24 hour time use diary (Magee et al 2014c).

Toddlers and Pre-schoolers

For both toddlers and pre-schoolers, cohort evidence suggests that children who spend more time engaged with electronic media have poorer sleep outcomes in later childhood (Magee et al 2014c; Marinelli et al 2014).

After adjusting for several covariates, children who increased their TV viewing time (to more than 1.5 hours per day) between aged two to four years, had reduced sleep time at aged four years (β=-0.34; 95%CI=-0.63 to -0.06). Reducing TV viewing did not change sleep time at follow-up (Marinelli et al 2014).

Dose-response associations were found. Among toddlers, each additional hour of daily TV was associated with decreased sleep time at follow-up (β=−0.11; 95%CI, –0.18 to −0.03) (Marinelli et al 2014). For pre-schoolers, Magee et al (2014c) reported that each 1-hour mean increasein media use was associated with a 3.6-minute mean decrease in sleep duration. A one hour mean decrease in sleep duration was associated with a 4.8- to six minute mean increase in media use.

The association between sleep and media use was reported to be bi-directional for pre-schoolers (Magee et al 2014c). Higher media use (i.e., combined TV /computer use) at aged four years predicted shorter sleep duration at two years later (β=−0.06; 95%CI=−0.10 to −0.02), and vice versa. Less sleep time at aged four years predicted more media use (β = −0.10, 95%CI: −0.14 to −0.05) and computer use (β=0.03, 95%CI=−0.05 to −0.01)

Several associations did vary by demographic variables. The link between media use and sleep varied by maternal education. It was significant for children whose mothers had at least completed high school. Computer use only predicted future sleep for children in the highest income group (β =-0.25, 95% CI=-0.49 to -0.02). Higher TV viewing (at aged four years) predicted less sleep time at aged six years for children whose mother had a tertiary qualification (β=−0.08; 95%CI= −0.12 to −0.03).

Summary

Overall, cohort evidence suggests toddlers and pre-schoolers who spend more time engaged with electronic media have poorer sleep outcomes in later childhood than those who engage less.

Le Blanc et al (2012) did not assess the association between sedentary behaviour and sleep.

B4 Academic literature on sleep and health outcomes

Indicators of poor sleep included short sleep time, curtailed sleep[6] and frequency of child waking up during the night. Short sleep time was the most frequently measured indicator. Age-specific sleep duration cut-points were used to delineate short sleep for an infant versus that for a toddler or pre-schooler.

B4.1 Number of studies reviewed for sleep

In contrast to the PA and sedentary behaviour topics, no systematic review of sleep on health outcomes among children aged from birth to four years was found; however, a meta-analysis by Hemmi et al (2011) focused on infancy behaviours (crying, sleeping, feeding) and included four studies relevant to *Allen + Clarke*'s review.

Allen + Clarke's review identified six relevant studies (covered in nine articles):

- obesity/adiposity (four studies)
- psychosocial health (three studies)
- cognitive abilities (one study), and
- sedentary behaviour (one study).

No articles meet the inclusion criteria for cardiovascular health, risk/injury, or PA outcomes.

Indicators of poor sleep included short sleep time (Bonuck et al 2015; Magee et al 2014a; Taveras et al 2014; Carter et al 2011) or curtailed sleep (Taveras et al 2014). Measurement timeframes included usual 24 hour period (Taveras et al 2014), typical or average weekday time (Bonuck et al 2015; Carter et al 2011) or total weekly sleep time (Magee et al 2014a). Two studies included nap times in their assessments (Maggee et al 2014a; Taveras et al 2014) and two did not (Bonuck et al 2015; Carter et al 2011). Parental reports were used to assess sleep times in all studies except one. Carter et al's study measured sleep objectively with accelerometers.

One New Zealand study (Carter et al 2011) was reviewed.

A summary of findings is included in Tables H and I (pages 93-94).

B4.2 Sleep and adiposity/obesity

Findings are based on four cohort studies, one of which was based in New Zealand (Carter et al 2011). One study focused on infants (Taveras et al 2014), two focused on toddlers (Bonuck et al 2015; Carter et al 2011) and one focused on pre-schoolers (Magee et al 2014a).

[6] Taveras et al (2014) defined curtailed sleep as repeated low sleep duration reported over several years.

Infants

Among a cohort of 1,046 infants, Taveras et al (2014) found that chronic sleep curtailment (from infancy into childhood) was associated with poorer outcomes across a range of adiposity indices at aged seven years. Children experiencing chronic curtailment had higher BMI z-score (+0.48 unit), larger skinfold thickness (+4.22mm), total FM (0.72), trunk FM (+0.36mm), larger waist circumference (+3.61cm) and larger hip circumference (+2.78cm). Those with the most curtailed sleep were three to seven times more likely to be obese than those with the lowest levels of curtailed sleep. This pattern was consistent, although not always significant, within each development periods of infancy, and early- and mid-childhood. This consistency of pattern suggests that there is no 'critical period' of sleep curtailment that impacts adiposity outcomes the most.

Toddlers and pre-schoolers

All three cohort studies found shorter sleep time to be associated with poorer outcomes.

Bonuck et al (2015), in their study of 1,899 pre-schoolers, found those with longest sleep times at aged 2.5 years (≥12.5 hours) were less likely (OR=0.50), and those with the shortest sleep times at ages 4.75 and 6.75 years (≤ 10hours)-were more likely (OR = 1.64 to 2.04) to be obese at aged 15 years.

Based on data from Magee et al's (2014a) study of 2,984 Australian pre-schoolers, less sleep among children aged four years was linked with higher BMI four years later (at aged eight years). When potential mediators (TV, computer, PA) were considered, the sleep-BMI association was weakened slightly, and become non-significant. Higher TV viewing (but not computer use or PA) at aged six partially mediated the association between sleep at aged four years and BMI at aged eight years (β=-0.009, P=0.05). This sleep-BMI relationship varied by income (children in the second highest income group had reduced sleep and higher BMI) and maternal obesity (children whose mothers were underweight had longer sleep and lower BMI).

A dose-response relationship was reported from a New Zealand study of 244 toddlers (Carter et al 2011). After accounting for several confounders (eg, diet, PA, birthweight and maternal factors), each additional hour of sleep per night between aged three to five years was associated with a 0.39 unit reduction in BMI and a 0.48 reduction in fat mass index at aged seven years. A BMI change of 0.49[7] units for a child with average height equates to a body weight difference of 0.7kg.

Summary

Curtailed and short sleep as an infant, toddler or pre-schooler negatively impacts adiposity in later childhood. New Zealand-based evidence supports the existence of

[7] This value is based on the minimally adjusted model, whereas the earlier figure of 0.39 is based on the fully adjusted model.

a dose-response relationship as among New Zealand children, increased sleep time as a toddler and pre-schooler was associated with increased reduction in BMI during mid-childhood.

None of the studies in Hemmi et al discussed the relationship between sleep and obesity/adiposity.

B4.3 Sleep and psychosocial health

Findings are based on three cohort studies: two studies focused on infants (Magee et al 2014b; Price et al 2012) and one study on toddlers (Sivertsen 2015). Various indicators of sleep were measured. These included frequency of sleep problems over past two weeks (Price et al 2012), total daily sleep time during a 24 hour period including naps (Sivertsen et al 2015), frequency of waking up during night time (Sivertsen et al 2015), and total weekly sleep time including naps (Magee et al 2014b). Parental/maternal reports were used to assess sleep times via a single question (Sivertsen et al 2015; Price et al 2012) or 24 hour time use diary (Magee et al 2014b).

Infants

For infant, mixed results emerged from the two cohorts studied. A cohort study of 3,000 infants (Magee et al 2014b) found four distinct sleep profiles[8] (i.e., typical sleepers, initially short sleepers, persistent short sleepers, and poor sleepers) were associated with health-related quality of life during early childhood (at aged six and seven years). Compared with typical sleepers:

- persistent short sleepers had lower physical (β=20.17, p=0.005), emotional (β=20.20, p=0.001), and social (β=20.16, p=0.006) health-related quality of life, and
- poor sleepers and initially short sleepers had poorer physical health-related quality of life (β=20.35, p=0.003; β=20.13, p=0.004, respectively).

Persistent short sleepers and poor sleepers appeared to come from families in lower socioeconomic backgrounds.

The second, and much smaller cohort study of 326 infants (Price et al 2012), found no association between child sleep problems (as reported by parents) and child's psychosocial health (eg, health-related quality of life and child-parent relationship) at aged six years. This was evident whether sleep problems were present at a single time point or at multiple time points between aged four and 24 months (Price et al 2012).

[8] Description of the profiles are located in the definition table.

Toddlers

Evidence from a cohort of 32,000 toddlers (Sivertsen et al 2015) suggests that a sleep-psychosocial health relationship exists and that it varies in a dose-response manner. At aged 18 months, sleeping less than ten hours a day or waking during the night at least three times predicted more internalising and externalising problems at aged five years. Toddlers who:

- experience the highest number of waking's during the night were three times more likely to be at risk of internalising problems (RR=3.19) and almost twice as likely to be at risk of internalising problems (RR=1.69), and
- sleep less than 10 hours daily were almost twice as likely to at risk of internalising (RR=1.59) and externalising (RR=1.77) problems.

Summary

Poor sleep as an infant or toddler is linked to poorer psychosocial health indicators in later childhood. This finding is consistent with material presented in Hemmi et al's 2011 study.

Hemmi et al's 2011 findings

- Poor sleep habits impact psychosocial outcomes negatively. Infant sleep problems had a small effect (es=0.24) on internalising behaviours, a moderate effect (es=0.42) on general behavioural problems and a large effect (es=1.30) on attention-deficit/hyperactivity disorder. The four studies reviewed included a mix of parent-perceived problems and measuring specific sleep issues.

B4.4 Sleep and cognitive abilities

Findings in this section are based on one cohort study of 11,000 toddlers (Bonuck et al 2012). This study examined the link between behavioural sleep problems and special education needs.

Toddlers

Bonuck et al (2012) found parent-reported behavioural sleep problems (eg, refusing to go to bed, waking early on a regular basis, difficulty going to sleep and nightmare frequency) was associated with special education needs. The continued presence of sleep problems at each age-related time point (i.e., aged 18, 30, 42 and 57 months) was associated with a seven percent increase (OR=1.07) in likelihood of special education needs at each time point. This relationship almost reached significance (OR=1.08, 95%CI=1.00–1.17) when controlling for the strong effect of IQ (OR=6.17, 95%CI=5.10–7.48).

Summary

Based on one large cohort study, sleep problems appear to be higher in children with special education needs.

None of the studies in Hemmi et al discussed the relationship between sleep and obesity/adiposity.

B4.5 Sleep and sedentary behaviour

Findings are based on one cohort study (Magee et al 2014c) of over 3,400 pre-schoolers. This study found a bi-directional relationship between sleep and sedentary behaviours. All findings have been presented been discussed (see page 71).

B4.6 Sleep and PA

No articles were found examining the relationship between sleep and PA.

B5 Discussion

B5.1 Overall findings

Based on the best-available, but limited evidence, all three health behaviours (PA, sedentary behaviour and sleep) appear to be associated with health outcomes, to varying degrees.

PA and health outcomes

For PA, the available evidence suggests:

- higher PA levels have a positive association with adiposity for infants
- motor skills are positively associated with communication skills for toddlers, and
- PA interventions had limited impact on improving motor skills, sedentary behaviour or adiposity in pre-schoolers.

Given the lack of available evidence or low quality of evidence, conclusions could not be drawn for the effect of PA on psychosocial health indicators, cognitive abilities (for infants and toddlers), motor skills (for infants), cardiovascular health (all age groups), risk/injury (all age groups) or sleep (all age groups).

This aligns with some conclusions drawn by Timmons et al (2012), which found:

> *"… in infants, there was low- to moderate-quality evidence to suggest that increased or higher physical activity was positively associated with improved measures of adiposity, motor skill development and cognitive development. In toddlers, there was moderate-quality evidence to suggest that increased or higher physical activity was positively associated with bone and skeletal health. In pre-schoolers, there was low- to high-quality evidence on the relationship between increased or higher physical activity and improved measures of adiposity, motor skill development, psychosocial health, and cardiometabolic health indicators."*

Sedentary behaviour and health outcomes

For sedentary behaviour, higher screen-time (including TV viewing) was associated with poorer health outcomes. The available evidence suggests:

- higher or increased TV viewing is associated with higher adiposity in toddlers
- TV-BMI relationship is bi-directional (i.e., toddlers who watch more TV had higher BMI values in later childhood and toddlers with higher BMI spent more time watching TV in later childhood)
- more time engaged with electronic media is associated with poor sleep outcomes for toddlers and pre-schoolers
- high computer use by pre-schoolers (from high income families only) is associated with less sleep
- increased media use is negatively associated with psychosocial health indicators in pre-schoolers
- type of TV content (eg, fast-paced content) decreases cognitive abilities (i.e., executive functioning), temporarily among pre-schoolers, and
- interventions targeting reduced TV viewing had limited impact on adiposity i.

Given the lack of available evidence or low quality of evidence, conclusions could not be drawn for the effect of sedentary behaviours on sleep (for infants), psychosocial health indicators (for infants), cognitive abilities (for infants and toddlers), motor skills (all age groups), cardiovascular health (all age groups), or risk/injury (all age groups).

The above findings align with some of the conclusions drawn by Le Blanc et al (2012), which found:

> *"…low- to moderate- quality evidence to suggest that increased television viewing is associated with unfavourable measures of adiposity and decreased scores on measures of psychosocial health and cognitive development. No evidence existed to indicate that television viewing is beneficial for improving psychosocial health or cognitive development. In several instances a dose–response relationship was evident between increased time spent watching television and decreased psychosocial health or cognitive development."*

Sleep and health outcomes

Poor sleep habits were consistently associated with poorer health outcomes in later childhood. Infants, toddlers and pre-schoolers with high curtailed sleep or short sleep times were found to have higher BMI values, increased fat mass, greater risk of obesity, lower health-related quality of life, and/or higher media use and TV viewing. Persistent short sleepers had lower physical, emotional and social functioning outcomes.

B5.2 Dose-response

Although limited in quantity, dose-response relationships were found between media use and sleep, and sleep and adiposity. For electronic media use:

- each additional hour of daily TV between aged two to four years was associated with decreased sleep time at aged six years (Marinelli et al 2014)
- a one hour mean increase in media use was associated with a 3.6-minute mean decrease in sleep duration (Magee et al 2014c), and
- a one hour mean decrease in sleep duration was associated with a 4.8 to six minute mean increase in media use (Magee et al 2014c).

For sleep, each additional hour of sleep per night between aged three years to five years was associated with a 0.39 unit reduction in BMI and a 0.48 reduction in fat mass index at aged seven years (Carter et al 2011). Additional evidence of dose-response relationships were evident in the systematic reviews by Timmons et al (2012) and Le Blanc et al (2012): both found a dose response relationship between PA and adiposity.

Dose-response evidence is crucial to help determine how much PA, sedentary behaviour, and sleep is necessary to promote healthy growth and development (and therefore what the content of any national population level recommendations should be). Such evidence is emerging but is not yet sufficiently large enough or varied enough to provide definitive recommendations about frequency, intensity, duration, type and context to inform public policy or national guidelines.

B5.3 Adiposity most common health outcome examined

Adiposity/obesity was the most frequently examined health outcome. It is also an outcome that was linked to all three health behaviours. Of the 21 studies reviewed, more than half (14 studies) examined adiposity indicators. Consequently, confidence in the conclusions drawn for this health outcome is higher than conclusions made for the others.

Evidence suggests higher PA, not FMS, is associated with improved adiposity indicators among infants (De Vries et al 2014; Schmidt Morgen et al 2013; Sijtsma et al 2013; Benjamin Neelon et al 2012). Interventions studies exerted little-to-no impact on adiposity among pre-schoolers. Out of three studies, the one intervention (Annesi et al 2013b) where positive changes did occur, larger changes were seen in overweight and obese children. Mixed findings is not surprising given the multitude of factors that contribute to obesity. It is unlikely that small increases in movement

alone, whether measured by milestones, FMS or PA levels, will impact weight status greatly without other behavioural changes (eg, nutritional intake, TV viewing habits, sleep habits). Variations in measurement, exposure variables, samples, and interventions tested may have contributed to the findings observed.

A detrimental effect of sedentary behaviour on adiposity outcomes was seen in two out of four studies. Cohort evidence on infants (Sijtsma et al 2013) and toddlers (Fuller-Tyszkiewicz et al 2012) supported this negative association. Interventions targeting reduced TV viewing had no impact on adiposity indicators (BMI z-scores) among pre-schoolers (Yilmaz et al 2015; Birken et al 2012).

Short or curtailed sleep increased the risk of obesity and higher BMI in later childhood and adolescence. A consistent association seen in all four cohort studies on infants (Taveras et al 2014), toddlers (Carter et al 2011) and pre-schoolers (Magee et al 2014a). A dose-response relationship was observed from New Zealand evidence. Each additional hour of sleep per night between aged three years to five years was associated with reductions in BMI. The authors concluded that at an individual level, the results may seem small; however, when applied across a population, such a change could have large public health benefits.

In addition to adiposity, all three health behaviours appear to be associated with other health outcomes. The available research describing these links, however, is more limited. Better motor skills were positively associated with communication among toddlers (Wang et al 2012). More media use and TV viewing increased the risk of poor family functioning and emotional problems (Hinkely et al 2014) and poorer sleep habits (Magee et al 2014c) among pre-schoolers. Also, the type of TV content watched (eg, fast-paced TV) appears to impact executive functioning negatively among pre-schoolers (Lillard and Peterson 2011). Short sleep times predicted poorer psychosocial outcomes including internalising, externalising problems (Sivertsen et al 2015) and reduced quality of life (Magee et al 2014b).

B5.4 No studies on risk/injury outcomes

No studies were found that examined risk/injury outcomes of PA. As suggested by Timmons et al (2012), the absence of evidence potentially reflects the low-risk, play-type activity participated in during infancy and early childhood years which. This may be especially so in recent years because of more safety regulations and rules applied by parents, schools, local councils and government around play and/or play equipment.

B5.5 Strength of associations and impacts seen are typically small

Where associations do exist, the strength of the associations are typically small. This finding is consistent across all three health behaviours. The small effect sizes may be a:

1. reflection of the many factors that can exert an effect on health outcomes, other than PA, sedentary behaviour and sleep, and
2. consequence of the measurement tools inability to fully capture the behaviours and, in turn, underestimate the strength of the relationships.

As mentioned by Carter et al (2011) in relation to the sleep-BMI association, if small changes at an individual level, at a population, such changes could have large public health benefits.

B5.6 Interventions had low success rate

Interventions targeting increased PA or a reduction in screen had low success in changing health outcomes. Of the eight interventions reviewed, six were PA focused intervention and two were screen use interventions. Each intervention targeted one or more health outcomes. No RCTs on sleep interventions were identified. Ability of sleep interventions to improve future health remains unknown.

Among the intervention studies (non-, cluster-, and parallel RCTs), a range of intervention modalities were tested from active play through to structured/organised PA opportunities and reducing screen time. Infant-focused interventions were brief, simple, and pragmatic (eg, nurse advice at check-ups and swimming classes). For toddlers and pre-schoolers, all interventions were delivered through childcare centre settings. Only two of the eight interventions positively impacted at least one outcome. Advice given to parents about recommended infant PA and motor skill development led to favourable changes in adiposity indices but had no effect PA or motor development.

Swimming classes for infants had no impact on motor development.The Start for Life I nitiative improved adiposity indicators over nine months but had no impact on reducing time spent being sedentary. Similarly, a six-week play intervention had no impact on sedentariness or PA. The Youp'là Bouge initiative had no impact on adiposity, psychosocial health or motor skills. In contrast, a policy-driven, multicomponent, and multi-environment initiative enhanced motor skill performance. Targeting reduced screen time, a family based intervention had no impact on adiposity but did reduce the amount of aggressive behaviours (as reported by parents). A ten minute behavioural counselling at annual health visit had no effect on adiposity levels one year later.

The inability of PA interventions to change sedentary behaviours is not unexpected. Every day children have sufficient time to be highly active and highly sedentary. While PA may displace time in more sedentary pursuits at a particular point in time, it is unlikely that a small change in PA behaviour (eg, 30 minutes of daily structured PA) would result in a significant change in the sedentary behaviour when examining behaviours across a school day, a full 24-hour day, or over a week.

Intervention strategies and implementation may have contributed to the low success rate. Most interventions were of short duration, lacked long term follow-up and/or were not intensive or different enough to exert an effect above usual practice control. In one study, implementation was not consistent across experimental groups because not all interventions strategies were mandatory although this is reflective of what might happen in real world settings. Power calculations were infrequently reported (and potentially not executed) and outcomes of interest in this review were often secondary outcomes. Thus, many intervention studies may have been insufficiently powered to detect change.

Behaviour change theory underpinned most interventions. A key strength of the interventions reviewed. Socio-cognitive theory was reflected in the Start for Life, Youp'là Bouge, and Might Moves initiatives. Socio-ecological based approaches, which included family-, community-and environment-based strategies to varying degrees, were seen. Intervention delivery was often through a single environment (childcare centres and baby clinics). Taking a holistic life-course approach may led to better success (eg, implementing initiatives that span more than one environment and considers transition periods (eg, from pre-school to school) to provide persistent messaging and support).

B5.7 Evidence on PA- FMS link is mixed

In contrast to cross-sectional evidence which supports a PA-FMS link (Bellows et al 2013; Robinson et al 2012; Williams et al 2008), RCT evidence is not so convincing. Three of the four interventions found no effect on motor skills among infants and pre-schoolers. The one initiative that impacted a range of motor-skill related fitness tests (eg, balance and sprinting) took a socio-ecological approach to behaviour change and included individual-, child-centre-, and community-based strategies. Motor skill performance was tested using quantitative assessment (measuring the outcome of the movement (eg, faster running time or threw further distance). From a pedagogy perspective, using qualitative assessments where proficiency of the movement is assessed would have been more useful. Qualitative assessments allow technique to be assess and provide constructive feedback on how to improve.

B5.8 Evidence on an association between all three health behaviours is limited

A bi-directional relationship between sleep and electronic media use was found. Short sleepers tend to have higher levels of TV viewing and screen use and higher screen use was associated with poorer sleep habits (Magee et al 2014c). Limited-to-no evidence exists for the PA-sedentary behaviour or PA-sleep relationships.

B6 Key limitations associated with this literature review

The findings and conclusions drawn need to be considered in light of limitations relating to the:

- number and quality of studies included in this review
- body of New Zealand-specific research
- age groups covered by the evidence base for children aged under five years,
- measurement and definition of key parameters, and
- methodological issues including confounders.

B6.1 Number of studies

Published evidence focusing on children aged under five years is limited. Including cross-sectional evidence may boost the number of studies reviewed and potentially strengthen the conclusions drawn, especially for sleep. Of note, Timmons et al (2012) found their systematic review conclusions on PA and health were similar to

those drawn from reviews that included cross-sectional studies and informed PA recommendations for Australia and the UK.

B6.2 New Zealand-specific research

Published New Zealand-centric research is also extremely limited; only one New Zealand-based study was identified. Seeking access to and analysing existing New Zealand data sources could provide an efficient way to gain some New Zealand-specific insights in the short term. Potential data sources include previously conducted university studies, the *Growing Up in NZ Longitudinal Cohort Study*, and evaluation-based evidence from the Under 5 Energize project.

B6.3 Age groups

Most studies focused on pre-schoolers compared with toddlers and infants. A potential reflection of the added difficulty in defining and measuring PA and health outcomes in the very young age bands. Benjamin Neelon et al (2012) noted that:

> *"Recommendations for physical activity in infancy are scarce, and even defining physical activity for infants is challenging; researchers are just beginning to examine the importance of early movement experiences."*

B6.4 Measurement and definition issues

Lack of common approaches to measurement and defining PA, sedentary behaviour and sleep exists. Such heterogeneity in measurement reduces the ability to compare findings between studies.

Across the 21 studies, most measurements of the health behaviours (PA, sedentary behaviour and sleep) were obtained subjectively through parental report. Only five studies assessed health behaviours using objective measurement tools.

Accelerometers were used to measure PA in four studies, sedentary behaviour in two studies, and sleep in one study. One study assessed PA objectively with pedometers. Objective tools overcome the inaccuracies and biases of subjective tools like questionnaires and parental recall. However, differences in application and use (eg, position worn, epoch length (a defined interval used to record movement data), definitions of valid days, non-wear time and unsealed pedometers) can impact results and hinder cross-study comparisons.

Among the seven studies examining the impact of sedentary behaviour on health outcomes, all studies relied on crude screen-time indicators (eg, TV viewing, media use and computer use) subjectively measured through parental reports. Definitions of low and high screen-time often differed between studies hindering cross-study comparisons.

While a crude indicator, TV viewing is still the main screen-media used by very young children (Colmar Brunton 2015). It remains a good indicator of screen-based sedentary behaviour, but not of overall sedentariness. Other indicators that provide a more holistic view of sedentariness (like sitting time) need consideration.

For sleep research, no standardised definitions or measurement approaches exist. Consequently, variations in measuring sleep and defining short sleep based on time-based cut-points differed between studies. A range of indicators were used that focused on night-time sleep duration, daily sleep including naps, and frequency of children waking up during the night. Maternal reports of bed- and wake-times was typically used to indicate sleep duration, a method that overlooks potential nocturnal awakenings. Whether parental reports or more objective tools like accelerometers are used, defining short sleep will still be based on arbitrary cut points. Global norms for age-specific time sleep times have recently been proposed based on meta-analysis of observational data from different countries (Galland et al 2012). Such information may provide a basis upon which cut-points can be determined.

B6.5 Generalisability of the findings

Issues relating to external validity were noticed in cohort and RCT studies. These included measurement issues (eg, reduction in wear time of accelerometers across measurement time points), low recruitment response rates, high exclusion rates (>50 percent), and unrepresentative samples which reduce the generalisability of the findings.

B6.6 Process evaluation

Process evaluation was overlooked in most RCTs, with the exception of one (Bonvin et al 2013). While RCTs are considered the gold-standard for clinical research, including process evaluation would add value to the insights gained to help better understand reasons for an effect (or lack thereof) and how the initiative could be improved for future rollout by adding to discussion of practical significance.

B6.7 Covariates

Most studies (but not all) adjusted findings by standard child and family demographic covariates and for RCTs ensuring baseline demographic variables did not differ significantly between intervention and control groups. Not all findings were adjusted for known covariates related to the topic being investigated. Given the majority of studies examined adiposity outcomes, an overview of the covariates accounted for are summarised in Table C (overleaf). The number of studies is presented first and the number of studies adjusting for the co-variate is included in brackets ().

Table C: Proportion (number of studies) of studies adjusting findings by relevant covariates

	Covariates					
Relationship examined	**PA levels**	**Sedentary**	**Nutrition**	**Sleep**	**Maternal**	**Family**
PA – adiposity (seven studies)	14 (1)	0	28 (2)	0	42 (3)	57 (4)
TV – adiposity (four studies)	0	25 (1)	0	0	0	25 (1)
Sleep – adiposity (four studies)	25 (1)	50 (2)	25 (1)	75(3)	75 (3)	100 (4)
Nutrition variables could include breastfeeding practice, age solids introduced and child's nutritional intake. Sedentary variables could include time spent watching TV, computer use, total screen time, TV ownership and TV in bedroom. Sleep variables could include sleep duration and the number of times a child wakes wakes up during the night. Maternal variables could include maternal BMI and pre-pregnancy BMI. Family variables covers income, education, socioeconomic and occupation variables.						

B7 Tables

Section B7 contains the following tables

- Table D and Table E (pages 87-90) provides detailed overview of study characteristics and key findings on articles examining the impact of PA on health outcomes.
- Table F and Table G (pages 91-92) provides detailed overview of study characteristics and key findings on articles examining the impact of sedentary behaviour on health outcomes.
- Table H and Table I (pages 93-94) provides detailed overview of study characteristics and key findings on articles examining the impact of sleep habits on health outcomes.
- Tables J to L (pages 95-97) shows the covariates adjusted for the articles reviewed by *Allen + Clarke.*

Table D: Overview of study characteristics for PA articles

Reference	Country	Study design	Sample (age, n) (baseline)	Age or timeframe (follow up)	Exposure focus	Exposure	Control	Outcome and measurement tool
Infants								
De Vries et al (2014)	Netherlands	RCT_C	Two weeks 143 children	2.5 years	PA and FMS	Delivered via Well-baby clinics. Nurses advised parents on stimulating age-appropriate motor development and physical activity for one hour per day. Advice given during regular visits at two weeks and two, four, eight and 11 months.	Standard care. No activity recommendation.	**Adiposity:** BMI (WHO), WC, HC, SF, %BF (bio -impedance). **Motor skills**: Gross motor skills (Dutch Second Edition of the Bayley Scales of Infant and Toddler. Development, Third Edition (Bayley-III). **PA** Total daily PA (accelerometer).
Hitzert et al (2014)	Northern Netherlands	Cohort_P	Three months 74 children	Five years 11 months	Motor skills	Age appropriate movements at aged three months – composite scores (eg, age-adequate repertoire, posture) and detailed movements (eg, antigravity movement). Video assessment by qualified assessor.	NA	**Cognition:** Intelligence, attention, verbal memory, visual spatial perception, visual- motor integration, ADHD, emotional competencies (various questionnaires). **Motor skills:** motor proficiency (qualitative assessment using Prechtl's method).
Jorge et al (2013)	Brazil	Non-RCT	Seven to nine months 12 children	Post intervention = four months	PA focus	One 45 minute swim class per week for four months (16 classes).	No systematic practice.	**Motor skills:** Developmental status (observation, Alberta Infant Motor Scale (AIMS)).
Schmidt Morgen et al (2013)	Denmark	Cohort_P	Five months 25,148 children	Seven years	Motor skills	Age achieved sitting and walking. Parental report at aged 18 month interview.	NA	**Adiposity:** BMI and BMI z-score (WHO cutpoints), birthweight.
Sijtsma et al (2013)	Netherlands	Cohort_P	Nine months 1,283 children	24 months	PA	Time spent moving unrestrictedly per day at aged nine months. Parental report.	NA	**Adiposity**: BMI z-score, weight-for-height, weight-for-age, and WC-for-age z-scores (WHO cutpoints).
Benjamin Neelon et al (2012)	USA	Cohort_P	Infant 741 children	Three years	Motor skills	Age achieved motor milestones: rolling over, sitting, crawling and walking by maternal report when infants are aged six months, one year and two years old.	NA	**Adiposity:** Overall adiposity, central adiposity (SF), BMI z-score (CDC cut points).
Toddlers								
Wang et al (2012)	Norway	Cohort_P	1.5 years 62,944 children	Three years	Motor skills	Fine (throw, stack blocks, turn book pages) and gross motor skills (walking). Maternal report, Ages and Stages Questionnaire.	NA	**Cognitive:** Communication (maternal report, Ages and Stages questionnaire).
Pre-schoolers								
Zhou et al (2014)	China	QE	4.5 years 357 children Two childcare centres	Post intervention = 12 months	PA	Delivered in childcare centre setting. Included centre-, family-, and community- based strategies such as PA policy, PE curriculum, food services training, parent education, internet website for support, family events, community playground renovation and community health promotion events.	Usual childcare standards.	**Adiposity**: %BF, FM, MM, BMI and BMI z-score (CDC). **Fitness**: Agility, run, jumping, throwing, flexibility, balance, crawling and sprinting (norm referenced battery test from the Chinese National Measurement Standards on People's Physical Fitness for young children). **Process evaluation:** PA levels, food preparation, fidelity of intervention implementation.
Annesi et al (2013a)	USA	RCT_C	4.7 years 338 children Seven schools and 19 classes	Post intervention = eight weeks	PA	Start for Life initiative delivered in pre-school setting. 30 minutes of daily, highly structured PA for eight weeks that promoted VPA and MVPA. Included cognitive behavioural techniques (self-management/self-regulatory skills like reframing negative talk, goal setting, tracking and assessing achievement to build children's perceptions of mastery and ability.	Usual 30 minutes of structured PA.	**PA:** MPA and VPA during - day (accelerometer, 15 second epoch). **Sedentary:** Time spent sedentary during pre-school day (accelerometer, 15 second epoch).
Annesi et al (2013b)	USA	RCT_C	4.4 years 1,154 children 26 classes	Post intervention = nine months	PA	As above but for nine months duration.	NA	**PA:** As above. **Sedentary:** As above. **Adiposity**: BMI (USA normative data).
Bellows et al (2013)	USA	RCT_C	Three to five years 201 children Four childcare centres	Post intervention = 18 weeks	Motor skills	Mighty Moves initiative. Delivered in childcare centre setting. Eighteen week structured programme focused on FMS with 15-20 minute teacher-led sessions. Four sessions per week (72 total). Included a home component. Focus on gross motor skill. Received a 12-week nutrition program called Food Friends.	Twelve week nutrition program Food Friends.	**Motor skills:** Gross motor quotient (GMQ), stability, locomotor, and object manipulation (Peabody Developmental Motor Scales, Second Edition). **Adiposity**: BMI, BMI z-scores (CDC criteria). **PA**: total, weekday, weekend steps (pedometer, six days including weekend).
Bonvin et al (2013)	Switzerland	RCT_C	3.3 years 648 children 58 centres	Post intervention = nine months	PA	Youp'là Bouge initiative. Government-led programme delivered through childcare centres. Mandatory strategies were environment changes and staff training. Recommended strategies were daily PA session, structured PA curriculum, and parent involvement.	Waiting list control. Continued regular programme.	**Motor skills:** Gross motor skills (obstacle course if climbing up/down stairs; running; balance; getting up; landing after jumping) (adapted from the Zurich Neuromotor Assessment test). **Adiposity:** BMI (IOTF criteria). **Psychosocial:** Quality of life (PedsQL 4.0 Generic Core Scales questionnaire). **PA:** MVPA, VPA during pre-school day (accelerometer, 15 second epoch).
O'Dwyer et al (2013)	England	RCT_C	4.5 years 240 children	Post intervention =	PA	A six-week active play intervention delivered in pre-school setting. One 60 minute session per week. Led by active play professional	Usual PA practice. Given same	**Sedentary:** Daily time spent being sedentary (accelerometer, five second epoch, seven days).

Reference	Country	Study design	Sample (age, n) (baseline)	Age or timeframe (follow up)	Exposure focus	Exposure	Control	Outcome and measurement tool
			Two pre-schools	six weeks and six months		for the first two weeks, then co-instruction with teacher for weeks 3 and 4, and by the teacher for weeks 5 and 6.	resource pack but no guidance on its use.	**PA:** Daily PA (accelerometer, five second epoch, seven days).

RCT_C Cluster RCT
RCT_P Parallel RCT
Cohort_P Prospective cohort
PI Post intervention

De Vries et al (2014) and Sijtsma et al (2013): Both studies used data from the same cohort population - Groningen Expert Center for Kids with Obesity (GECKO) Drenthe birth cohort. **Annesi et al (2013a) and Annesi et al (2013b)** reported on data from the same intervention study. **Hitzert et al 2013:** Motor optimality included fidgety movement quality, movement repertoire, movement patterns, postural patterns and movement quality. Detailed motor aspects included normal movement patterns (manipulation, antigravity, midline arms, midline legs), normal (variable fingers) and abnormal (flat posture, ATN posture) postural patterns, and abnormal movements (monotonous, jerky, stiff/cramped). Age-adequate motor repertoire includes the presence of antigravity, midline leg, and manipulation movements.
Age (baseline) represented mean age of age range at baseline. **Age/timeframe (follow up)** represented mean age/age range at follow-up or timeframe between measurement points. If multiple ages are provided, indicates study had multiple follow-ups.

Table E: Overview of key findings for PA articles

Reference	Exposure	Outcome	Findings – Impact /Association between Exposure and Outcome variables
Infants			
De Vries et al (2014)	Activity advice via Well Child Clinic nurses	Adiposity	**(NI)** BMI, WC, HC. Tendency for lower %BF (1.1 percent) in intervention group. **(+)** Intervention group had lower sum of SF (-2.8mm, p=0.003) supra-iliacal SF (-1.1mm, p=0.002) than controls at follow up. **(+)** At follow up, intervention group girls had lower weight (-0.7kg), BMI (-0.7kg/m^2), WC (-1.8cm), HC (-1.8cm), and sum of skinfolds (3.6mm). Intervention group boys and girls had lower supra-iliacal SF (boys: -1mm, p=0.02; girls:-1mm, p=0.04). Intervention overweight children had lower sum of SF (-7.0mm, p < 0.05), biceps SF (-2.4mm), subscapular SF (-1.7mm, p < 0.05) and supra-iliacal SF (-2mm, p=<0.05).
		MS	**(NI)** Gross motor skills
		PA	**(NI)** Accelerometer-determined daily PA levels
Hitzert et al (2014)	Sub categories of Motor Optimality List	Cognition	**(-)** Age-adequate motor repertoire associated with poorer total IQ (β=-0.40; 95%CI=-0.69 to -0.11; p=0.008), verbal IQ (β=-0.38; 95%CI=-0.71 to -0.05; p=0.026), performance IQ (β=-0.42; 95%CI=-0.84 to -0.00; p=0.049), attention (β =-0.62; 95%CI=-1.17 to -0.16; p=0.011) and visual-motor integration (β=-0.30; 95%CI=-0.55 to -0.05; p=0.02). **(-)** Normality postural patterns associated with attention, (β=-1.42; 95%CI=-2.58 to -0.27; p=0.017). **(+)** Smooth and fluent quality concurrent repertoire associated with better total (β =0.63, 95%CI=0.08 to 1.17; p=0.026) and internal (β=0.80, 95%CI=0.23 to 1.38; p=0.007) behavioural outcomes.
	Detailed motor patterns		*Normal motor patterns:* **(+)** Presence of variable finger postures associated with better visual-spatial perception (β=0.33; 95%CI=0.09 to 0.56; p=0.008). **(-)** Presence of antigravity movements associated with lower total IQ (β=-0.50; 95%CI=-0.92 to -0.09; p=0.018) and lower verbal IQ (β =-0.68; 95%CI=-1.13 to -0.23; p=0.003). **(-)** Presence of midline leg movements associated with lower performance IQ (β=-0.55; 95%CI=-1.07 to -0.03; p=0.04). **(-)** Presence of manipulation movements linked to poorer sustained attention (β=-0.65; 95%CI=-1.29 to -0.01; p=0.046) and poorer visual-motor integration (β=-0.31; 95%CI=-0.60 to -0.02; p=0.035). *Abnormal motor patterns:* **(+)** Monotonous concurrent motor repertoire associated with more behavioural problems (β=-0.31, 95%CI=-0.57 to –0.05; p=0.02). **(NA)** Tendency for absence of antigravity movements to be associated with better recognition (OR=4.4, 95%CI=0.9–21; R^2=0.17; p=0.070). **(-)** Absence of variable finger postures was associated with borderline and abnormal visual-spatial perception (OR=20, 95% CI=1.7–238; R^2=0.39).
		Motor skills	**(NA)** Most detailed movement patterns (like antigravity movements and midline leg movements) was not related to motor proficiency. **(+)** Monotonous concurrent motor repertoire associated with better ball skills (β=0.31, 95%CI=0.05–0.57; p=0.021).
Jorge et al (2013)	Swim classes	MS	**(NI)** Raw developmental status score improved for control (Cohen's r = 0.69) and intervention (Cohen's r = 0.90) groups. **(NI)** Improved percentile rank (against Canadian norm data) for intervention group only from pre to post-test (20.5 versus 51.0, p=0.02, r=0.47; 95%CI=-.06, 79).
Schmidt Morgen et al (2013)	Age achieved sitting and walking	Adiposity	**(NA)** Age at sitting and walking not linked to overweight at aged seven years. **(-)** Later age of walking (β=-0.021; 95%CI=-0.003; -0.002) but not sitting (β=-0.005; 95%CI=-0.015; 0.005) was associated with lower BMI z-score at aged seven years.
Sijtsma et al (2013)	Unrestricted movement	Adiposity	**(NA)** WC-for-age z score **(+)** ≥ five hours of unrestricted movement (versus < five hours) at aged nine months linked to lower increase in weight-for-height (mean ± SD = -0.11 ±0.70 versus -0.04 ±0.80, P < 0.01) and weight-for-age (mean ± SD = -0.08 ±0.76 versus -0.02 ± 0.79, p < 0.05) z-scores between the aged nine and 24 months.
Benjamin Neelon et al (2012)	Age of attainment of four gross motor milestones	Adiposity	**(NA)** BMI z scores. Also, crawling age not associated with adiposity. **(-)** Higher central adiposity associated with later age (≥ six months versus < six months) of rolling over (+0.04mm, 95%CI=0.008-0.07) and sitting up (+0.02mm; 95%CI=0.001, p=0.05). **(-)** Higher overall adiposity (+0.98mm, 95%CI=0.05, 1.91) linked to later age of walking (≥15 months compared to <12 months).
Toddlers			
Wang et al (2012)	Fine and gross MS	Cognitive	**(+)** Motor skills at aged 1.5 years predicted communication skills at aged three years (cross-lagged coefficient = 0.38).
Pre-schoolers			
Annesi et al (2013a)	Eight-week Start for life initiative	PA	**(NI)** For VPA the time x group interaction was marginally significant [F (1, 344) = 3.60, p =.058, $n^2_{p=0.}$011)]. Equated to an increase of approx. 9.3 percent in VPA time for the treatment group relative to the control. **(+)** For MVPA, significant effect for time x group interaction [F (1, 344) = 4.98, p=0.026, $n^2_{p=0.}$015]. Equates to an increase of approx. 8.7 percent in MVPA time for the treatment group relative to the control. **(+)** Approx. 40 more minutes of MVPA per week, with approx. 30 of that time being VPA.
		Sedentary	**(NI)** For sedentary time, time x group interaction did not reach statistical significance relative to the control, [$F_{1, 344}$ = 1.96, p=0.162, $n^2_{p=0.}$006].
Annesi et al (2013b)	Nine-month Start for life initiative	Sedentary	**(NI)** No difference in accelerometer-determined sedentary time during pre-school day between the treatment and control groups.
		Adiposity	**(+)** Significant time × group interaction [F (1, 1152) =5.16, p =0.023, η^2_p=0.004] for BMI. Greater reduction for intervention group than controls. **(+)** Small decrease in BMI (0.14 BMI unit) for the intervention group. Decreased BMI greater among overweight/obese children in intervention group (-0.51 BMI unit).
		PA	**(+)** Greater percentage of the pre-school day spent in MVPA [F (1, 883) = 5.87, p =0.016, η2=0.007] and VPA [F (1, 883) = 15.93, p <0.001, η2=0.018]. Equated to approximately 30 minutes per week more.
O'Dwyer et al (2013)	Six-week play intervention	PA	**(NI)** Accelerometer-determined daily PA time.
		Sedentary	**(NI)** Accelerometer-determined daily sedentary time.
Bonvin et al (2013)	Youp'là Bouge initiative	MS	**(NI)** Gross motor skills (relative to the control group).
		Adiposity	**(NI)** BMI (relative to the control group).
		PA	**(NI)** Accelerometer-determined daily PA time (relative to the control group).
		Psychosocial	**(NI)** Quality of life (relative to the control group).
Bellows et al (2013)	Mighty Moves initiative	Adiposity	**(NI)** BMI. **(+)** Children with lower BMI at baseline made more improvements in locomotive skills than those with high BMIs. Healthy weight children made improvements in all motor skill indices.
		PA	**(NI)** Pedometer-determined daily PA.
		Motor skills	**(+)**Compared to control, intervention group had improved motor skills (overall gross motor performance, stability, locomotor and manipulation).

Reference	Exposure	Outcome	Findings – Impact /Association between Exposure and Outcome variables
			(+) Significant time x group interaction for overall gross motor performance [F (1, 186) = 22.62, p=0.0005], stability [F (1, 194) = 17.73, p=0.0005], locomotor [F (1, 194) = 10.44, p=0.001] and object manipulation [F (1, 186) = 8.26, p=0.005]. Control group had a decrease in overall gross motor performance and stability skills indicating a slower rate of motor development.
Zhou et al (2014)	Multiple PA strategies intervention	Adiposity	**(NI)** BMI and BMI z-scores **(+)**Positive impact. Less gains in %BF (−1.35%, p=<0.0001), FM (−0.55 kg, p=0.0001) and more gain in MM (+0.48 kg, p=0.0001) and total body weight (+0.36 kg, p=0.02) than the control group.
		Fitness	**(+)** Positive intervention impact. Improved 20-meter agility run (−0.74 seconds, p=0.0001), broad jump for distance (8.09 cm, p=0.0001), tennis ball throwing (0.52 meters, p=0.006), sit and reach (0.88 cm, p=0.03), balance beam walk (−2.02 seconds, p=0.0001), 30-meter sprint (−0.45 seconds, p=0.0001), and 20-meter crawl (−3.36 seconds, p=0.02).
(NI): No intervention impact on outcome variable; (**NA)**: No association with outcome variable **(+)** Positive association or impact on outcome variable **(-)** Negative association or impact with outcome variable.			**Bellows et al 2013**: Only cross-sectional analysis (at baseline and at post-test) was conducted on the PA – FMS link. Consequently, these results are note presented. **Zhou et al 2014:** Because the intervention had a nutrition component, only results regarding fitness are discussed in text. **Annesi et al (2013a) and Annesi et al (2013b)** reported on data from the same intervention study.

Table F: Overview of study characteristics for sedentary behaviour articles

Reference	Country	Study Design	Sample (age, n) (baseline)	Age /timeframe (follow up)	Exposure focus	Exposure	Control	Outcome and measurement tool
Infants								
Sijtsma et al (2013)	Netherlands	Cohort_P	Nine months 1,283 children	24 months	Sitting time	Time spent sitting in baby seat at aged nine months (questionnaire, parent report)	NA	**Adiposity**: BMI Z scores, weight-for-height, weight-for-age, and WC-for-age Z scores (WHO criteria).
Toddlers								
Marinelli et al (2014)	Spain	Cohort_P	Two years 1,245 children	Four years	TV viewing	Hours of TV viewing per day during weekdays and weekend (parent report)	NA	**Sleep:** Sleep duration per day, including naps (parent report questionnaire).
Fuller-Tyszkiewicz et al (2012)	Australia	Cohort_P	2.29 years 4,724 children	4.25 years 6.32 years	TV viewing	Total weekly TV viewing (parental report)	NA	**Adiposity:** BMI (IOTF criteria).
Pre-schoolers								
Yilmaz et al (2015)	Turkey	RCT_P	3.5 years (two years to six years) 412 children	Post intervention = eight weeks, and at two, six and nine months	Screen time	Eight-week family based intervention targeting reduced screen time (TV, video, computer/video game use). Included printed material and interactive CD. Plus counselling call.	No intervention	**Adiposity:** BMI z scores (CDC criteria). **Psychosocial:** Child aggression (parent report, Child Behaviour Checklist). **Sedentary**: Time spent (minutes) using media time (TV, video, internet) in past week, average weekly, weekday and weekend day media time (parent report).
Hinkley et al (2014)	8 European countries	Cohort_P	4.3 years (two years to six years) 3,604 children	6.3 years	Electronic media use	Weekday TV, weekend TV, weekday e-game/ computer use, and weekend e-game/computer use (parent report)	NA	**Psychosocial:** Emotional problems and peer problems (Strength and Difficulties Questionnaire, self-report); Self-esteem, emotional wellbeing, family functioning, social networks (Measuring Health-Related Quality of Life in Children and Adolescents Revised Version, parental report).
Magee et al (2014c)	Australia	Cohort_P	Four to five years 3,427 children	Six to seven years Eight to nine years	Electronic media use	Total media use (TV, computer), TV viewing (parent report, 24 hour time use diaries)	NA	**Sleep duration**. Combined weekday and weekend day time (parent report, 24 hour time use diaries).
Birken et al (2012)	Canada	RCT_P	Three years 160 families	Four years	Screen time	Primary care setting. Brief 10 minute behavioural counselling intervention at annual health maintenance visit in primary care to reduced screen time. Targeted behaviours link to screen time (eg, eating in front of TV, TV in bedrooms or family rules)	Screen-time based counselling session about selection of screen time programs and internet safety.	**Sedentary**: Total time (minutes) the child was in a room with the television or video/ DVD on or playing video games or using the Internet during the previous weekday and the previous weekend day (primary outcome), number of TV versus, presence of a TV in their bedroom (parental report). **Adiposity:** BMI z-score (WHO criteria).
Lillard and Peterson (2011)	USA	QE	Four years 60 children	Same as baseline	TV Content	Watching a nine minute fast paced television cartoon.	Nine minutes of educational cartoon or drawing	**Cognition**: Executive functioning composite score (Tower of Hanoi HTKS task, and backward digit) and delay of gratification score.

RCT_C Cluster RCT
RCT_P Parallel RCT
Cohort_P Prospective cohort
PI Post intervention

Fuller-Tyszkiewicz et al (2012) and **Magee et al (2014a, 2014b, 2014c)**: Both studies used data from the same cohort study - Longitudinal Study of Australian Children (LSAC).
Fuller-Tyszkiewicz et al (2012): Results based on Cohort B findings only. Cohort K was outside the age criterion for this review.
Marinelli et al (2014): Results from two of the three population cohorts presented (Sabadell and Valencia). The third cohort, Menorca, did not met the age criterion for this review.
Hinkley et al (2014): Eight European countries were Belgium, Cyprus, Estonia, Germany, Hungary, Italy, Spain, and Sweden. Description of psychosocial indicators: emotional problems (eg, often worried, unhappy, depressed); peer problems (eg, rather solitary, picked on/ bullied), self-esteem (eg, proud of self, pleased with self), emotional well-being (eg, had fun, was scared), family functioning (eg, felt fine at home, got on well with parents) and social networks (eg, liked by other children, got on well with friends)
Age (baseline) represented mean age of age range at baseline.
Age/timeframe (follow up) represented mean age/age range at follow-up or timeframe between measurement points. If multiple ages are provided, indicates study had multiple follow-ups.

Table G: Overview of key findings for sedentary behaviour articles

Reference	Exposure	Outcome	Findings
Infants			
Sijtsma et al (2013)	Sitting time (time spent sitting in baby seat at aged nine months)	Adiposity	**(+)** Never using a baby seat at aged nine months associated with a higher decrease in weight-for-height z-score between aged nine and 24 months (mean ± SD = -0.34 ±0.63, p=<0.05) versus using baby seat for less than one hour (mean ± SD = -0.02 ±0.77, p=<0.05) or more than one hour (mean ± SD = -0.00 ±0.71, p=<0.05). **(+)** Never using a baby seat at aged nine months was associated with a higher decrease in weight-for-age z-score between aged nine and 24 months (mean ± SD = -0.30 ±0.82, p=<0.05) versus using baby seat for more than one hour (mean ± SD = -0.11 ±0.74). **(-)** Using a baby seat for less than one hour at aged nine months linked to higher decline in waist circumference-for-age z-score between aged nine and 24 months (mean ± SD = -0.22 ±1.04, p=<0.05) versus using baby seat for more than one hour (mean ± SD = -0.03 ±1.15).
Toddlers			
Marinelli et al (2014)	TV viewing (hours per day during weekdays and weekend)	Sleep	**(-)** ≥ 1.5 hours per day of TV at baseline was associated reduced sleep at aged four years (β=-0.29; 95%CI=-0.49 to -0.09). **(-)** Increased TV levels (from < 1.5 hours/day to ≥ 1.5 hours per day) from aged two to four years was associated reduced sleep at aged four years (β=-0.34; 95%CI=-0.63 to -0.06). **(NA)** Reduced TV levels (from ≥ 1.5 hours/day to <1.5 hours per day) from aged two to four years was not associated with change in sleep time. **DR** Each additional hour of daily TV was linked to less sleep duration (β = 0.11; 95%CI, –0.18 to −0.03).
Fuller-Tyszkiewicz et al (2012)	TV viewing (total weekly time)	Adiposity	**(-)** Higher TV viewing predicted higher future BMI (correlation = 0.11 to 0.12). **(NA)** Dietary intake did not mediate the BMI-TV association. Relationship between TV viewing and BMI is bi-directional. Individuals who watch TV are more likely to gain weight, and individuals who are heavier are also more likely to watch TV.
Pre-schoolers			
Yilmaz et al (2015)	Eight-week family based intervention targeting reduced screen time	Adiposity	**(NA)** BMI Z scores. Both groups had increased BMI z-scores.
		Psychosocial	**(+)** Less aggressive behaviours by intervention group than controls at aged nine months (3.35 versus 3.85, p=0.001). **(+)** Less delinquent behaviours by intervention group than controls at aged nine months (3.45 versus 3.85, p=0.006).
		Sedentary	**(+)** Lower media time (minutes per day) by intervention group than control at two months post intervention (39 minutes per day versus 87 minutes per day, p=<0.001). Six months post intervention (25 minutes per day versus 85 minutes per day, p=0.001). At nine months post intervention (21 minutes per day versus 93 minutes per day). **(+)** Lower media time (hours/week) by intervention group than controls at aged nine months for mothers (6.30 versus 7.55 hours per week), fathers (5.10 versus 6.66 hours per week), and caregivers (5.56 versus 7.31 hours per week).
Hinkley et al (2014)	Electronic media use (TV, e-game or computer use)	Psychosocial	**(NA)** Media use not linked to peer problems, self-esteem, emotional well-being or social network. **(-)** Media use linked to emotional problems and family functioning, but links differed by sex. **DR** Each additional hour of weekday e-game/ computer use was associated an increase in the likelihood of girls (OR=2.0) being at risk for emotional problems **DR** Each additional hour of weekday TV viewing was associated with an increase in the likelihood of girls (OR=1.3) and boys (OR=1.2) being at risk for poor family functioning **DR** Each additional hour of weekend TV viewing was associated with an increase in the likelihood of girls (OR=1.3) being at risk for poor family functioning.
Magee et al (2014c)	Total media use (TV or computer), TV viewing	Sleep duration	*Computer use:* **(NA)** Computer use (at aged four years) did not predict subsequent sleep time at aged six years. Income moderated the relationship. More computer use predicted less sleep time for those highest income group [β = −0.25, 95%CI=-0.49 to -0.02]. *TV viewing:* **(-)** Higher TV viewing (at aged four years) was associated with less sleep duration (at aged six years) when mothers had a tertiary qualification [β=−0.08; 95%CI=−0.12 to −0.03] but not when mothers had or had not completed high school. *Media use:* **(-)** Higher total media use (at aged four years) associated with lower sleep duration at aged six years [β=−0.06; 95%CI=−0.10 to −0.02]. **DR** A one hour mean change in media use was associated with a 3.6-minute mean change in sleep duration. This relationship varied by maternal education. Inverse association seen for those who mother had completed at least high school but not seen for those who mothers had no completed high school. Results from this study support bidirectional relationship between media use and sleep. Findings for the impact of sleep on media findings, see Table B.7.3B.
Birken et al (2012)	Brief 10 minute behavioural counselling intervention	Adiposity	**(NI)** After one year, no effect on BMI.
		Sedentary	**(NI)** After one year, no differences between intervention and control groups in mean total weekday minutes of screen time (60 versus 65 minutes, p=0.68) or mean total weekend day minutes of screen time (80 versus 90 minutes, p=0.33).
Lillard and Peterson (2011)	Watching a nine minute long fast paced television cartoon	Cognition	**(NA)** For executive functioning composite score and delay of gratification task no difference between educational TV and drawing groups. **(-)** Fast pace TV group had poorer executive functioning composite score than the drawing group (p=0.004). (NA) Difference in executive functioning between fast pace and educational TV groups approached significance (p=0.05). **(-)** Fast pace TV group did worse on the delay of gratification task than the drawing (p=0.03) and educational TV (p=0.02) groups. Fast-paced television group waited less time.

(NI): No intervention impact on outcome variable
(**NA)**: No association with outcome variable
(+) Favourable association or impact on outcome variable
(-) Unfavourable association or impact with outcome variable
DR dose response

Table H: Overview of study characteristics for sleep articles

Reference	Country	Study Design	Sample (age, n) (baseline)	Age or timeframe (follow up)	Exposure focus	Exposure	Outcome and measurement tool
Infants							
Magee et al (2014b)	Australia	Cohort	Birth to one year 2,926 children	Seven to seven years	Sleep duration	Weekly sleep time (parent report, 24 hour time use diaries).	**Psychosocial:** Physical, emotional and social functioning (parent report, Pediatric Quality of Life Inventory).
Taveras et al (2014)	USA	Cohort	6.2 months 1,046 children	Annually from aged one to seven years	Sleep duration	Curtailed sleep and time spent sleeping during usual 24 hour day (maternal report, mailed questionnaires).	**Adiposity**: total and trunk FM (x-ray absorptiometry), BMI z score (US national reference data), WC, HC, central obesity (SF).
Price et al (2012)	Australia	Cohort	Seven months 326 children	Six years	Frequency of sleep problems	Frequency of sleep problems at aged four months 12 months and 24 months (parent report).	**Psychosocial:** Mental health (Strengths and Difficulties Questionnaire, child report), child health-related quality of life (Pediatric Quality of Life Inventory 4.0, parent and child reports), and child–parent relationship (Child-Parent Relationship Scale Short Form).
Toddlers							
Bonuck et al (2015)	England	Cohort	Six months 1,899 children	Seven years 10 years 15 years	Sleep duration	Typical weekday sleep time calculated from weekday bed- and wake-times. Measured at aged 18 months and at aged 2.5, 4.75, 5.75, and 6.75 years (maternal report).	**Adiposity**: BMI (IOTF criteria).
Sivertsen et al (2015)	Norway	Cohort	18 months 32,662 children	4.4 years	Sleep duration	Sleep duration per day (hours) and frequency of child waking during the night (maternal report).	**Psychosocial:** Internalising problems and externalizing problems (parent report, Child Behaviour Checklist).
Bonuck et al (2012)	England	Cohort	Six months 11,049 children	Eight years	Behavioural sleep problems	Number of behavioural sleep problems (past year, repeated across five age-related time points: 18, 30, 42, and 57 months old, parent report).	**Cognitive**: Special education needs.
Carter et al (2011)	New Zealand	Cohort	Three years 244 children	Six-monthly from aged three years to seven years	Sleep duration	Average night-time sleep time (hours/day) over ages three, four and five 5 years (accelerometer, parent report activity log).	**Adiposity**: BMI, FM and FFM (primary outcome) (bioelectrical impedance; dual energy x-ray absorptiometry).
Pre-schoolers							
Magee et al (2014a)	Australia	Cohort	Four to five years 2,984 children	Six to seven years Eight to nine years	Sleep duration	Total sleep time per week (hours) (parent report, 24 hour time use diary).	**Adiposity:** BMI **TV viewing:** weekly TV viewing, computer use. Total media use (TV + computer) (parent report).
Magee et al (2014c)	Australia	Cohort	Four to five years 3,427 children	Six to seven years Eight to nine years	Sleep duration	Total sleep time per week (hours) (parent report. 24 hour time use diary.	**Electronic media use:** Total media use (TV, computer), TV viewing (parent report, 24 hour time use diaries).

Age (baseline) represented mean age of age range at baseline.
Age/timeframe (follow up) represented mean age/age range at follow-up or timeframe between measurement points. If multiple ages are provided, indicates study had multiple follow-ups.

Magee et al (2014b): Examples of psychosocial indicators are: Physical functioning (eg, problems with walking), emotional functioning (eg, feeling sad), social functioning (age, problems socialising).
Carter et al (2011): Findings based on data from the Family Lifestyle, Activity, Movement and Eating (FLAME) study.
Bonuck et al (2012): Behavioural sleep problems were based on report of ≥ five out of seven behavioural sleep problems (child refused to go to bed, regularly woke early, regularly had difficulty sleeping, regularly had nightmares, regularly got up after being put to bed, regularly woke in the night, and regularly got up after a few hours.
Bonuck et al (2015, 2012): Studies placed in toddler section as the first measurement of sleep occurred at aged 18 months.
Sivertsen et al (2015): Internalising problems include emotionally reactive, anxious/depressed and somatic complaints. Externalising problems included attention problems and aggressive behaviours.
Magee et al (2014a, 2014b, 2014c): Articles used data from the same cohort population - LSAC.

Table I: Overview of key findings for sleep articles

Reference	Exposure	Outcome	Findings
Infants			
Price et al (2012)	Frequency of sleep problems at ages four months, 12 months and 24 months (parent report).	Psychosocial	**(NA)** Most psychosocial outcomes at age 6y not associated with sleep problems at aged four months, 12 months or 24 months. Early sleep problems, whether measured at single or multiple time points, have little lasting effect on child, maternal, or child–parent outcomes to the time of school-entry. **(-)** Sleep problems (at aged 12 months) predicted poorer child psychosocial HOURQoL at aged six years (adjusted mean difference = -5.7, 95%CI=-10.7 to -0.6, p=0.03). **(-)** Sleep problems (at aged 24 months) predicted improved child–parent relationship at aged six years (adjusted OR=0.25, 95%CI=0.08 to 0.81, p=0.02)
Taveras et al (2014)	Curtailed sleep and time spent sleeping during usual 24 hour day (maternal report, mailed questionnaires).	Adiposity	**(-)** Higher curtailment associated with higher BMI z-score. Highest chronic sleep curtailment group had higher BMI z score (+0.48 Unit), SF (+4.22mm), total FM (0.72), trunk FM index (+0.36mm), WC (+3.61cm), HC (+2.78cm) at mid-childhood, compared with the lowest curtailment group. **(-)** Infants with the most curtailment were seven times more likely to be obese than those with the lowest sleep curtailment (based on the minimally adjusted model). This reduced to 3 times more likely when socioeconomic status was adjusted for, and non-significant TV viewing at mid childhood was adjusted for.
Magee et al (2014b)	Weekly sleep time (parent report, 24 hour time use diaries).	Psychosocial	**(NA)** Compared with 'typical sleepers', 'poor sleepers' had a trend towards poorer emotional and social health. **(-)** Compared with 'typical sleepers', 'persistent short sleepers' had lower physical (β=20.17, p=0.005), emotional (β= 20.20, p=0.001), and social (β=20.16, p=0.006) health-related QoL. **(-)** Compared with 'typical sleepers', 'poor sleepers' (β=20.35, P=0.003) and 'initially short sleepers' (β=20.13, p=0.004) had poorer physical health-related QoL.
Toddlers			
Carter et al (2011)	Average night-time sleep time (hours/day) over aged three, four and five years (accelerometer, parent report activity log).	Adiposity	**DR** Each additional hour of sleep at aged three to five years was associated with a reduction in BMI (-0.39 unit) at aged seven years in maximally adjusted model (and -0.49 unit seen in the minimally adjusted model). 61 percent reduction in risk of being overweight or obese at aged seven for each extra hour of sleep. **(+)** BMI difference explained by change in FM index (−0.43kg) than change in FFM index (−0.21). Finding based on minimally adjusted model. From maximally adjusted model, finding was not significant (FM index: −0.48kg; FFM index: −0.11, ns).
Bonuck et al (2012)	Number of behavioural sleep problems at aged 18, 30, 42 and 57 months (parent report).	Cognitive	**(-)** Behavioural sleep problems (BSP) were associated with a 7% increased odds (OR=1.07) of special education needs, for each ~1-year interval at which a BSP was reported (adjusted analysis without IQ included). BSP nearly attained significance (OR=1.08, 95%CI=1.00–1.17) when controlling for the strong effect of IQ (OR=6.17, 95%CI=5.10–7.48).
Bonuck et al (2015)	Typical weekday sleep time calculated from weekday bed- and wake-times. Measured at aged 18 months and at 2.5, 4.75, 5.75 and 6.75 years (maternal report).	Adiposity	**(NA)** Short sleep duration (≤ 10hours) at aged 18 months and at 2.5 and 6.75 years old was borderline significant with obesity. **(+)** Those with the longest sleep duration (≥12.5 hours) at aged 2.5 years were less likely to be obese at aged 15 years (OR=0.50, 0.26-0.97) in minimally adjusted analyses only. **(-)** Short sleep duration at aged 4.75 years (OR=2.04, 95%CI=1.36-3.04) and aged 5.75 years (OR=1.64, 95%CI=1.11-2.41) associated with increased odds of obesity at aged 15 years.
Sivertsen et al (2015)	Sleep duration per day (hours) and frequency of child waking during the night (maternal report).	Psychosocial	**(-)** Short sleep duration and frequent nocturnal awakenings at aged 18 months increased the risk of emotional and behavioural problems at aged five years. *Sleep duration:* **(-)** Findings reflect associations in dose-response manner. **(-)** Sleeping ≤10 hours/day (RR=1.59, 95%CI=1.23-2.08) or 11-12hours/d (RR=1.22, 95%CI=1.10-1.34) associated with increased risk of internalising problems at aged five years, compared to those sleeping 13-15 hours per day. **(-)** Sleeping ≤10 hours (RR=1.77, 95%CI=1.37-2.30) or 11-12hour (RR=1.13, 95%CI=1.02-1.25) associated with an increased risk of externalising problems at aged five years compared to 13-15 hours/day sleepers. *Frequency of waking up during the night:* **(-)** One or two nocturnal awakenings (RR=1.29, 95%CI=1.16-1.44) or ≥3 awakenings per night (RR=1.57, 95%CI=1.28-1.93) associated with higher risk of internalising problems at aged five years compared to those with few awakenings. **(-)** ≥ Three awakenings per night (RR=1.25, 95%CI=1.00-1.58) linked to higher risk of externalizing problems at aged five years compared to those with few awakenings. One or two nocturnal awakening was not significant.
Pre-schoolers			
Magee et al (2014a)	Total sleep time per week (hours) (parent report, 24 hour time use diary).	Adiposity: TV viewing	**(-)** Shorter sleep duration at aged four to five years associated with higher BMI at aged eight to nine years (β=-0.07, p=0.044). Relationship varied by maternal obesity (association seen in those with underweight mothers) and household income (association seen in second highest income group). **(-)** Less sleep at aged four years associated with higher TV time (β=-0.07, p=0.003) and computer use (β=-0.04, p=0.001) but not PA (as measured by time in organized sport/active play) at aged six years. Sleep-BMI relationship was partially mediated by weekly TV time (β=-0.009, p=<05) but not PA or computer use at aged six to seven years.
Magee et al (2014c)	Sleep time.	Media use (TV + Computer)	**(-)** Less sleep time (at aged four years) associated with more media use (β=−0.10, 95%CI=−0.14 to −0.05] and computer use [β=0.03, 95%CI=−0.05 to −0.01] at aged six. **DR** A one hour mean change in sleep duration was associated with a 4.8- to six minute mean change in media use. **DR** A one hour mean change in sleep duration was associated with a 4.8- to six minute mean change in media use. Results from this study support bidirectional relationship between sleep duration and media use. Findings for the impact of media use on sleep findings, see Table B.7.2B.

(NI): No intervention impact on outcome variable
(**NA)**: No association with outcome variable
(+) Favourable association or impact on outcome variable
(-) Unfavourable association or impact with outcome variable
DR Unfavourable dose response

Magee et al (2014a) and **Magee et al (2014c)**: Both studies used data from the same cohort study - LSAC.
Bonuck et al (2012) and **Bonuck et al (2015)**: Both studies used data from the same cohort study - Avon Longitudinal Study of Parents and Children.
Bonuck et al (2012): Special education needs included speech, language, communication needs; specific learning difficulty; and behavioural, emotional, and social difficulties.
Magee et al (2014a, 2014b, 2014c): Articles used data from the same cohort population - LASC.

Table J: Covariates adjusted for in the PA articles

		De Vries (2014)	Jorge (2013)	Benjamin-Neelon (2012)	Hitzert (2014)	Schmidt Morgen (2013)	Sijtsma (2013)	Wang (2012)	Annesi (2013a)	Annesi (2013b)	O'Dwyer (2013)	Bonvin (2013)	Bellows (2013)	Zhou (2014)
Study Characteristics	Target	Infants	Infants	Infants	Infants	Infants	Infants	Toddlers	Pre-schoolers	Pre-schoolers	Pre-schoolers	Pre-schoolers	Pre-schoolers	Pre-schoolers
	Study design	Cluster RCT	Non-RCT	Cohort	Cohort	Cohort	Cohort	Cohort	Cluster RCT	Cluster RCT	Cluster RCT	Cluster RCT	Cluster RCT	QE
	Exposure	PA/MS	PA	MS	MS	MS	PA	MS	PA	PA	PA	PA	MS	PA
	Outcomes (PA, MS: motor skills ADI: Adiposity, Cog: Cognitive, PS – Psychosocial)	ADI, MS, PA	MS	ADI	Cog.	ADI	ADI	Cog.	PA, SED	PA, SED, ADI	SED, PA	MS, ADI, PS, PA	MS, ADI, PA	ADI, Fitness
Covariates	Obesity													
	PA time										X	x		
	Sedentary time										X			
	When solids introduced					x								
	Breastfeeding (duration/exclusive)			x		x								
	BMI - child			X							X		x	
	Mother's pre-pregnancy BMI			x		x								
	Father's BMI			x										
	Parents MI/obesity	x												x
	Psychosocial													
	Child's quality of life											x		
	Maternal psychological distress							x						
	Child													
	Age / grade level			x	x							x	x	x
	Sex			x							X	x	x	x
	Race/ethnicity			x									x	
	Gestational age/length	x						x						
	Birthweight	x		x				x						
	6 month weight for length			x										
	Being first born	x												
	Health status at birth							x						
	Time spent at school										X			
	Pre-test measure											x		x
	Parents/Family													
	Age					x		x						
	Ethnicity										X			
	Income			x				x						x
	Native language							x						
	Education										X			x
	Maternal education			x	x			x						
	Maternal occupation					x								
	Smoking during pregnancy			x		x								
	Parity			x		x								
	Marital status / Single mother			x		x								
	Difficult mother-child relationship in first 6 months					x								
	Study design													
	Level of randomisation	x											x	

Table K: Covariates adjusted for in the sedentary activity articles

		Sijtsma (2013)	Marinelli (2014)	Fuller-Tyszkiewicz (2012)	Yilmaz (2015)	Birken (2012)	Lillard and Peterson (2011)	Hinkley (2014)	Magee (2014c)
Study Characteristics	Target Study design Exposure Outcomes (PA,, MS: motor skills ADI: Adiposity, Cog: Cognitive, PS – Psychosocial)	Infants Cohort Sitting time ADI	Toddlers Cohort TV viewing Sleep	Toddlers Cohort TV viewing ADI	Pre-schoolers Parallel RCT Screen time SED, ADI, PS,	Pre-schooler Parallel RCT Screen time SED, ADI	Pre-schoolers QE TV content Cog.	Pre-schooler Cohort Media use PS	Pre-schoolers Cohort Media use Sleep
Covariates	Obesity								
	TV ownership				x				
	Mother, fathers, and caregivers TV viewing time				x				
	Childs TV viewing time				x				
	TV in child's room				x				
	Child BMI (baseline / change from baseline)		x			x			x
	Sleep								
	Presence of sleep problems								x
	Cognitive								
	Child executive functioning		x						
	Maternal IQ		x						
	Child								
	Age / grade level				x		x	X	
	Sex		x		x				
	Race/ethnicity								
	Education				x				
	Parent/family								
	Income				x			X	x
	Paternal occupation				x				
	Maternal occupation				x				
	Socio-economic position							X	
	Education		x					X	
	Maternal education				x				x
	Paternal education				x				
	Maternal mental health status		x						
	Type of housing				x				
	Number of other children at home				x				
	Maternal marital status / Single mother status		x						

Table L: Covariates adjusted for in the sedentary activity articles

		Price (2012)	Taveras et al (2014)	Magee (2014b)	Carter (2011)	Bonuck (2012)	Bonuck (2015)	Sivertsen (2015)	Magee (2014a)	Magee (2014c)
Study Characteristics	Target	Infants	Infants	Infants	Toddlers	Toddlers	Toddlers	Toddlers	Pre-schoolers	Pre-schoolers
	Study design	Cohort	Cohort	Cohort	Cohort	Cohort	Cohort	Cohort	Cohort	Cohort
	Exposure	Problem sleeping	Sleep duration	Sleep duration	Sleep duration	Behavioural sleep problems	Sleep duration	Sleep duration Nocturnal awakening	Sleep duration	Sleep duration
	Outcomes (PA,, MS: motor skills ADI: Adiposity, Cog: Cognitive, PS: Psychosocial)	PS	ADI	PS	ADI	Special education needs	ADI	PS	ADI, TV viewing	Media use
Covariates	Obesity									
	Childs TV viewing time		x		x					
	Child PA time				x					
	Child Fruit-veg intake				x					
	Child Non-core food intake				x					
	Child breast fed (ever)					x				
	Child BMI baseline				x					x
	Child FFI /FFMI at baseline				x					
	Maternal pre-pregnancy BMI						x			
	Maternal BMI / weight status		x		x				x	
	Sleep									
	Child sleep duration				x					
	Child sleep problems			x					x	x
	Child sleep disorder breathing						x			
	Tonsillectomy/adenoidectomy						x			
	Child temperament	x		x						
	Child IQ					x				
	Child									
	Age / grade level		x				x			
	Sex	x	x	x	x		x	X	x	
	Race/ethnicity		x		x	x				
	Gestational age/length					x		X		
	Birthweight			x	x	x	x	X		
	Six-month weight for length and weight and height						x			
	Medical conditions			x		x				
	Child birth order	x								
	Parent/family									
	Maternal age		x					X		
	Age at time of delivery						x			
	Income		x		x				x	x
	Paternal social class (manual, professional)					x				
	Maternal employment status								x	
	Maternal education	x	x		x	x	x		x	x
	Household size								x	
	Financial hardship	x							x	
	Socioeconomic status	x								
	House adequacy (eg, crowdedness, homelessness)					x				
	Family adversity index					x				
	Family type (single, dual family)								x	
	Quality of parenting and home environment					x				
	Maternal psychological distress	x								
	Smoking during pregnancy				x					
	Parity		x				x	X		
	Smoking					x				

APPENDIX C

PROFILE-BASED DESCRIPTION OF CURRENT ADVICE ON PA, FMS, SEDENTARY BEHAVIOUR AND SLEEP FOR UNDER FIVES USED IN COMPARABLE COUNTRIES

Appendix C profiles advice on PA, FMS and sedentary behaviour from the following countries: Australia, Canada, Ireland, the UK and the USA. Specifically, it includes advice about the following PA and FMS guidelines:

- Australia: National Physical Activity Recommendations for Children (0-5 years) (Move and Play Every Day)
- Canadian Physical Activity Guidelines for the Early Years
- Canada: Long-Term Athlete Development 2.0
- Ireland: National Guidelines on Physical Activity for Ireland – Guidelines for Children and Young People (aged 2 -18 years)
- UK: Start Active, Stay Active: Physical activity guidelines for the early years (walking and non-walking)
- USA: Healthy Activity, Screen-time and Sleep in the Early Years (Obesity Prevention Source)
- USA: Active Smart: Physical Activity Guidelines for Children from Birth to Five Years, and
- USA: Caring for Our Children.

It also includes information about the following sedentary or sleep guidelines:

- Australia: Sedentary behaviour and screen-time included in the National Physical Activity Recommendations for Children (0-5 years)
- Canadian Sedentary Behaviour Guidelines for the Early Years

Each country's advice is described in a standard table format. Each table includes:

- Developing and publishing agencies and funding agency (if relevant)
- Year of development
- Target population
- Recommendations regarding the type and intensity, context, frequency and duration for either age groups or developmental stage (depending on the approach taken by the country)
- Resources available
- Development process, and rationale for this
- Evaluation material, and
- How it is used by the sector and the public.

Some information for some countries was not able to be obtained. This is noted in the tables.

GUIDELINES ON PA

<table>
<tr><th colspan="6">AUSTRALIA: National Physical Activity Recommendations for Children (0-5 years)</th></tr>
<tr><td>Organisation</td><td colspan="3">Department of Health (Australian Government)</td><td>Year</td><td>2009</td></tr>
<tr><td>Overview</td><td colspan="5">Infants (birth to one year): PA, particularly supervised floor-based play in safe environments, should be encouraged. Toddlers (one to three years) and pre-schoolers (three to five years) should be active every day for at least three hours, spread throughout the day.</td></tr>
<tr><td>Target population</td><td colspan="5">Birth to aged five years</td></tr>
<tr><td rowspan="4">Advice</td><td>Age</td><td>Type and intensity</td><td>Context</td><td>Duration</td><td>Frequency</td></tr>
<tr><td>For infants
(six months to one year)</td><td>Includes reaching and grasping, pulling and pushing, moving the head, body and limbs during daily routines, and supervised floor play including tummy time.</td><td>Supervised floor-based play.</td><td>None stated.</td><td>Several times throughout the day.</td></tr>
<tr><td>For toddlers
(one to three years)</td><td rowspan="2">Accumulated throughout the day and can include light activity like standing up, moving around and playing.</td><td rowspan="2">A variety of activities in different environments.</td><td rowspan="2">At least three hours per day.</td><td rowspan="2">Several times throughout the day.</td></tr>
<tr><td>For pre-schoolers
(three to five years)</td></tr>
<tr><td>Resources available</td><td colspan="5">National Physical Actvity Recommendations for Children (0-5 years)
Get up & Grow Healthy Eating and Physical Activity for Early Childhood
Move and Play Every Day</td></tr>
<tr><td>Development</td><td colspan="5">No evidence/methodology is provided for the development of the guidelines on birth to aged five years.</td></tr>
<tr><td>How it is used</td><td colspan="5">This is used by families and childcare professionals as a guide to activities with children.</td></tr>
<tr><td>Evaluation</td><td colspan="5">No evaluation has been undertaken for the National Physical Activity Recommendations for Children (0-5 years)</td></tr>
</table>

CANADA: Canadian Physical Activity Guidelines for the Early Years 0 – 4 Years					
Organisation	Canadian Society for Exercise Physiology			**Year**	2012
Collaborators	ParticipACTION				
Overview	Infants should be physically active several times daily particularly through interactive floor-based play.Toddlers and pre-schoolers should do at least 180 minutes of PA at any intensity spread throughout the day, including a variety of activities in different environments, activities that develop movement skills and progression toward at least 60 minutes of energetic play by five years of age. More daily PA provides greater benefits.				
Target population	0-4 Years				
Advice	**Age**	**Type and intensity**	**Context**	**Duration**	**Frequency**
	For infants (Less than one year)	None stated.	Through interactive floor-based play.	None stated.	Several times daily.
	For toddlers (one to two years)	At any intensity spread throughout the day.	A variety of activities in different environments and activities that develop movement skills.	At least 180 minutes.	More daily PA provides greater benefits.
	For pre-schoolers (three to four years)				
Resources available	Canadian Physical Activity Guidelines for the Early Years Canadian Physical Activity Guidelines for the Early Years Background Information Clinical Practice Guidlines for Physical Activity for the Early Years (aged 0 - 4 years)				
Development of guidelines	Guidelines were developed following a comprehensive systematic review on the effects of PA on infants, toddlers and pre-schoolers which included at least one health variables (adiposity, bone and skeletal health, motor skill development, psychosocial health, cognitive development and cardio-metabolic indicators) as well as statistical analysis (Timmons et al 2011).				
How it is used	As a guide				
Evaluation	None				

CANADA: Long-Term Athlete Development: 2.0					
Organisation	Canadian Sport for Life (Active Start)			**Year**	2014
Collaborators	Sport Canada				
Overview	• Provide organised PA for at least 30 minutes a day for toddlers and at least 60 minutes a day for pre-schoolers. • Provide unstructured PA (active play) for at least 60 minutes a day, and up to several hours per day for toddlers and pre-schoolers. Toddlers and pre-schoolers should not be sedentary for more than 60 minutes at a time, except while sleeping. • Provide PA every day regardless of the weather. • Starting in their infancy, provide infants, toddlers and pre-schoolers with opportunities to participate in daily PA that promotes fitness and movement skills. • Provide parents and care givers with age-appropriate information. • Ensure that children acquire movement skills that build towards more complex movements. These skills help lay the foundation for lifelong PA. • Encourage basic movement skills but develop depending on each child's heredity, activity experiences and environment. For children with a disability, access to age and disability-appropriate adapted equipment is an important contributor to success. • Focus on improving basic movement skills such as running, jumping, twisting, kicking, throwing and catching. These basic human movements are the building blocks for more complex activities. • Design activities that help children feel competent and comfortable participating in a variety of fun and challenging games and activities. • Ensure that games for young children are non-competitive and focus on participation. • Because girls tend to be less active than boys and children with a disability less active than their peers, ensure that activities are gender-neutral and inclusive so that active living is equally valued and promoted for all children.				
Target population	0-6 years				
Advice	**Age**	**Type and intensity**	**Context**	**Duration**	**Frequency**
	For infants (Birth – 1 year)	Provide infants with opportunities to participate in daily PA that promotes fitness and movement skills.	None stated.	None stated.	None stated.

	For toddlers (one to three years)	Encourage basic movement skills such as running, jumping, twisting, kicking, throwing and catching. Games for young children which are non-competitive and focus on participation	Organised and unstructured PA.	Thirty minutes organised PA and at least 60 minutes unstructured PA but up to several hours per day. Toddlers should not be sedentary for more than 60 minutes a day (except while sleeping).	Throughout the day.
	For pre-schoolers (three to five years)			Sixty minutes organised PA and at least 60 minutes unstructured PA but up to several hours per day. Pre-schoolers should not be sedimentary for more than 60 minutes a day (except while sleeping).	
Resources available	Long-term Athlete Development 2.0				
Development of guidelines	No methodology provided.				
How it is used	Used by families and childcare professionals as a guide to activities with children.				
Evaluation	None.				

<table>
<tr><th colspan="6">IRELAND: National Guidelines on Physical Activity for Ireland</th></tr>
<tr><td>Organisation</td><td colspan="3">Get Ireland Active</td><td>Year</td><td>2012</td></tr>
<tr><td>Collaborators</td><td colspan="5">Department of Health and Children and the Health Service Executive</td></tr>
<tr><td>Overview</td><td colspan="5">All children and young people should be active, at a moderate to vigorous level, for at least 60 minutes every day. Include muscle-strengthening, flexibility and bone-strengthening exercises three times a week.</td></tr>
<tr><td>Target population</td><td colspan="5">2 – 18 years</td></tr>
<tr><td rowspan="4">Advice</td><td>Age</td><td>Type and intensity</td><td>Context</td><td>Duration</td><td>Frequency</td></tr>
<tr><td>For infants
(birth to one year)</td><td colspan="4">Not covered by guidelines.</td></tr>
<tr><td>For toddlers
(one to three years)</td><td rowspan="2">Moderate to vigorous intensity such as aerobic, muscle and bone strengthening exercises such as running, riding a bike, jumping, hopping and climbing.</td><td rowspan="2">A variety of activities in different environments.</td><td rowspan="2">At least 60 minutes every day.</td><td rowspan="2">At least three times a week.</td></tr>
<tr><td>For pre-schoolers
(three to five years)</td></tr>
<tr><td>Resources available</td><td colspan="5">National Guidelines on Physical Activity for Ireland</td></tr>
<tr><td>Development of guidelines</td><td colspan="5">The guidelines were developed through a literature review. Health benefits of physical activity for children and young people (2-18) – summary of evidence (US Physical Activity Guidelines Advisory Committee, 2008).</td></tr>
<tr><td>How it is used</td><td colspan="5">As a guide for parents and childcare professionals.</td></tr>
<tr><td>Evaluation</td><td colspan="5">None.</td></tr>
</table>

UK: Start Active, Stay Active: Physical activity guidelines for early years (Under 5s)					
Organisation	Chief Medical Officers for the four Home Countries (England, Scotland, Northern Ireland and Wales)			**Year**	2011
Collaborators	Department of Health, Social Services and Public Safety (Northern Ireland), The Scottish Government, The Welsh Government, The Department of Health (UK/England), National Health Service.				
Overview	The guidelines for children who are not yet walking are that PA should be encouraged from birth, particularly through floor-based play and water-based activities in safe environments. Guidelines for children who are capable of walking are that children of pre-school age who are capable of walking unaided should be physically active daily for at least 180 minutes (three hours), spread throughout the day. All children aged under five years should minimise the amount of time spent being sedentary (being restrained or sitting) for extended periods (except time spent sleeping).				
Target population	Birth to aged five years				
Advice	**Age**	**Type and intensity**	**Context**	**Duration**	**Frequency**
	For infants (birth to one year)	Tummy time includes any time spent on the stomach including rolling and playing on the floor. Other activities include reaching for and grasping objects, pulling, pushing, and playing with other people. Parent and baby swim sessions.	Floor-based and water-based play.	None stated.	Throughout the day.
	For toddlers (one to three years)	Activities can be of any intensity (light or more energetic) and may include activities which involve movements of all the major muscle groups (i.e. the legs, buttocks, shoulders and arms, and movement of the trunk from one place to another) Energetic play includes climbing frames, riding a bike, running and chasing games, and walking/skipping.	A variety of activities in different environments.	180 Minutes.	Throughout the day.
	For pre-schoolers (three to four years)				

Resources available	Physical Activity Guidelines for Children (under five years) Physical Actvity Guidelines for Early Years (under five years) - for infants who are not yet walking Physical Activity Guidelines for Early Years (under five years) - for children who are capable of walking Start Active, Stay Active
Development of guidelines	A set of key documents were identified as the primary sources of evidence and used to underpin the development of UKs guidance. The key sources were: • Physical Activity Guidelines Advisory Committee Report (2008) from the Physical Activity Guidelines Advisory Committee formed by the US Department of Health and Human Services • Scientific reviews undertaken as part of the Canadian Physical Activity Guidelines review process • Review papers undertaken as part of the British Association of Sport and Exercise Sciences (BASES) consensus process • Where needed, individual high quality review papers or individual study papers reporting on relevant issues not covered in the US, Canadian or BASES review process.
How it is used	Used by families, childcare professionals and health care practitioners as a guide to activities with children.
Evaluation	None.

<table>
<tr><th colspan="6">USA: Healthy Activity, Screen Time and Sleep in the Early Years (Obesity Prevention Source)</th></tr>
<tr><td>Organisation</td><td colspan="3">Harvard School of Public Health</td><td>Year</td><td>2015</td></tr>
<tr><td>Overview</td><td colspan="5">Encourage daily PA among children in childcare: offer at least two to three outdoor opportunities for daily active play (weather permitting). Facilitate age-appropriate activity in short, regular bursts throughout the day:
Keep screen media turned off at all times around children under the aged two years. Limit any media viewing (television, cell phone, or digital media) in the childcare setting to no more than 30 minutes per week for children aged two years and older, since many children are already exposed to excessive levels of screen time in their homes. Ensure that children of all ages are not sitting longer than 15 to 30-minute intervals, unless during meals or naptime</td></tr>
<tr><td>Target population</td><td colspan="5">Early Years (age range not specified)</td></tr>
<tr><td rowspan="5">Advice</td><td>Age</td><td>Type and intensity</td><td>Context</td><td>Duration</td><td>Frequency</td></tr>
<tr><td>For infants
(birth to one year)</td><td>Tummy time in the prone position. Limited time spent restricted.</td><td>Supervised floor-based play.</td><td>Not stated.</td><td rowspan="3">Short, regular bursts spread throughout the day.</td></tr>
<tr><td>For toddlers
(one to three years)</td><td rowspan="2">Vigorous exercise which gets the child breathing deeper and faster than normal.</td><td rowspan="2">A variety of activities in different environments.</td><td>60 – 90 minutes every eight hour day.</td></tr>
<tr><td>For pre-schoolers
(three to four years)</td><td>90 – 120 minutes every eight hour day.</td></tr>
<tr><td>Resources available</td><td colspan="5">Healthy Activity, Screen Time and Sleep in the Early Years</td></tr>
<tr><td>Development of guidelines</td><td colspan="5">Based on a review of expert guidance from the American Academy of Pediatrics, the National Resource Center for Health and Safety in Child Care and Early Education, the Institute of Medicine, and others.</td></tr>
<tr><td>How it is used</td><td colspan="5">As a guide for parents and childcare professionals.</td></tr>
<tr><td>Evaluation</td><td colspan="5">None.</td></tr>
</table>

<table>
<tr><th colspan="6">USA: Caring for Our Children – National Health and Safety Performance Standards; Guidelines for Early Care and Education Programs.</th></tr>
<tr><td>Organisation</td><td colspan="3">American Academy of Pediatrics, American Public Health Association and National Resource Center for Health and Safety in Child Care and Early Education</td><td>Year</td><td>2011</td></tr>
<tr><td>Collaborators</td><td colspan="5">U.S. Department of Health and Human Services</td></tr>
<tr><td>Overview</td><td colspan="5">All children (birth to six years) should participate daily in:
a) Two to three occasions of active play outdoors, weather permitting;
b) Two or more structured or caregiver/teacher/adult-led activities or games that promote movement over the course of the day—indoor or outdoor;
c) Continuous opportunities to develop and practice age-appropriate gross motor and movement skills.
The total time allotted for outdoor play and moderate to vigorous indoor or outdoor PA can be adjusted for the age group and weather conditions. For example:
a) Outdoor play (weather permitting):
1) Infants (birth to twelve months of age) should be taken outside two to three times per day, as tolerated. There is no recommended duration of infants' outdoor play;
2) Toddlers (twelve months to three years) and pre-schoolers (three to six years) should be allowed sixty to ninety total minutes of outdoor play.
Infants should have supervised tummy time every day when they are awake. Caregivers/teachers should interact with an awake infant on their tummy. Infants should not be seated for more than fifteen minutes at a time, except during meals or naps. Infant equipment such as swings, stationary activity centers (exersaucers), infant seats (bouncers), and molded seats. used should only be used for short periods of time. A least restrictive environment should be encouraged at all times.
Time spent outdoors has been found to be a strong, consistent predictor of children's PA. Children can accumulate opportunities for activity over the course of several shorter segments of at least ten minutes each. Because structured activities have been shown to produce higher levels of PA in young children, it is recommended that caregivers/teachers incorporate two or more short structured activities (five to ten minutes) or games daily that promote PA.</td></tr>
<tr><td>Target population</td><td colspan="5">From birth to aged six years</td></tr>
<tr><td rowspan="2">Advice</td><td>Age</td><td>Type and intensity</td><td>Context</td><td>Duration</td><td>Frequency</td></tr>
<tr><td>For infants
(birth to one year)</td><td>Activities designed to improve gross motor and movement skills.</td><td>Supervised floor play (indoor and outdoor).</td><td>Short periods (i.e., three to five minutes) on their stomach increasing as the child enjoys/becomes accustomed to the activity.</td><td>Two or three times per day.</td></tr>
</table>

				There is no recommendation for duration of outdoor play. Infants should not be seated for more than 15 minutes.	
	For toddlers (one to three years)	Varied – some periods of moderate to vigorous activity.	Structured and unstructured play indoors and outdoors.	60 – 90 minutes of outdoor play and 60 to 90 minutes of moderate to vigorous PA per eight hour day.	Spread over the course of the day.
	For pre-schoolers (three to four years)			60 – 90 minutes of outdoor play and 90 to 120 minutes of moderate to vigorous PA per eight hour day.	
Resources available	Caring for Our Children: National Health and Safety Performance Standards				
Development of guidelines	The guidelines are based on contribution from 86 technical experts in the field of health and safety in early care and education. Reviews and recommendations were received from 184 stakeholder individuals including consumers of the information and organisations representing major constituents of the early care and education community. Caregivers/teachers, parents/guardians, families, health care professionals, safety specialists, early childhood educators, early care and education advocates, regulators, and federal, military, and state agencies all brought their expertise and experience to the revision of the guidelines.				
How it is used	Used by childcare professionals in planning activities for children in their care.				
Evaluation	None.				

USA: Active Start: Physical Activity Guidelines for Children Birth to Five Years			
Organisation	National Association for Sport and Physical Education	**Year**	2002
Collaborators	Shape America – Society of Health and Physical Educators		
Overview	Guidelines for Infants: 1. Infants should interact with caregivers in daily physical activities that are dedicated to exploring movement and the environment. 2. Caregivers should place infants in settings that encourage and stimulate movement experiences and active play for short periods of time several times a day. 3. Infants' PA should promote skill development in movement. 4. Infants should be placed in an environment that meets or exceeds safety standards for performing large-muscle activities. 5. Those in charge of infants' well-being are responsible for understanding the importance of PA and should promote movement skills by providing opportunities for structured and unstructured PA. Guidelines for Toddlers: 1. Toddlers should engage in a total of at least 30 minutes of structured PA each day. 2. Toddlers should engage in at least 60 minutes -- and up to several hours -- per day of unstructured PA and should not be sedentary for more than 60 minutes at a time, except when sleeping. 3. Toddlers should be given ample opportunities to develop movement skills that will serve as the building blocks for future motor skilfulness and PA. 4. Toddlers should have access to indoor and outdoor areas that meet or exceed recommended safety standards for performing large-muscle activities. 5. Those in charge of toddlers' well-being are responsible for understanding the importance of PA and promoting movement skills by providing opportunities for structured and unstructured PA and movement experiences. Guidelines for Pre-schoolers: 1. Pre-schoolers should accumulate at least 60 minutes of structured PA each day. 2. Pre-schoolers should engage in at least 60 minutes -- and up to several hours -- of unstructured PA each day, and should not be sedentary for more than 60 minutes at a time, except when sleeping. 3. Pre-schoolers should be encouraged to develop competence in fundamental motor skills that will serve as the building blocks for future motor skilfulness and PA. 4. Pre-schoolers should have access to indoor and outdoor areas that meet or exceed recommended safety standards for performing large-muscle activities. 5. Caregivers and parents in charge of pre-schoolers' health and well-being are responsible for understanding the importance of PA and for promoting movement skills by providing opportunities for structured and unstructured PA.		
Target population	From birth to aged five years		

<table>
<tr><td rowspan="4">Advice</td><td>Age</td><td>Type and intensity</td><td>Context</td><td>Duration</td><td>Frequency</td></tr>
<tr><td>For infants
(birth to one year)</td><td>PA dedicated to exploring movement, simulation and skill development.</td><td>Supervised structured and unstructured play.</td><td>Short periods</td><td rowspan="3">Regular intervals throughout the day</td></tr>
<tr><td>For toddlers
(one to three years)</td><td rowspan="2">Structured and unstructured play which targets movement and motor skills.</td><td rowspan="2">A variety of activities in different environments (indoor and outdoor).</td><td>30 minutes of structured PA per day and at least 60 minutes (up to several hours) of unstructured PA. Toddlers should not be sedentary for more than 60 minutes (unless sleeping)</td></tr>
<tr><td>For pre-schoolers
(three to five years)</td><td>60 minutes of structured PA per day and at least 60 minutes (up to several hours) of unstructured PA. Pre-schoolers should not be sedentary for more than 60 minUTES (unless sleeping)</td></tr>
<tr><td>Resources available</td><td colspan="5">Active Start: Physical Activity Guidelines for Children Birth to Five Years</td></tr>
<tr><td>Development of guidelines</td><td colspan="5">Based on a review of expert guidance from the American Academy of Paediatrics, the National Resource Centre for Health and Safety in Child Care and Early Education, the Institute of Medicine, and others.</td></tr>
<tr><td>How it is used</td><td colspan="5">As a guide for parents and childcare professionals.</td></tr>
<tr><td>Evaluation</td><td colspan="5">None.</td></tr>
</table>

GUIDELINES ON SEDENTARY BEHAVIOUR

<table>
<tr><th colspan="7">AUSTRALIA: Sedentary behaviour and screen time (0 – 5 years)</th></tr>
<tr><td>Organisation</td><td colspan="4">Department of Health (Australian Government)</td><td>Year</td><td>2011</td></tr>
<tr><td>Overview</td><td colspan="6">Children younger than ages two years should not spend any time watching television or using other electronic media (DVDs, computer and other electronic games). Children aged two to five years should be limited to less than one hour per day of sitting and watching television and the use of other electronic media (DVDs, computer and other electronic games). Infants, toddlers and pre-schoolers should not be sedentary, restrained or kept inactive for more than one hour at a time - with the exception of sleeping.</td></tr>
<tr><td>Target population</td><td colspan="6">Birth to aged five years</td></tr>
<tr><td rowspan="4">Advice</td><td>Age</td><td>Type and intensity</td><td>Context</td><td>Duration</td><td colspan="2">Frequency</td></tr>
<tr><td>For infants (birth to one year)</td><td colspan="5" rowspan="2">Screen-time is not recommended for babies and children less than two years of age, particularly in the early childhood setting, because it may:
• reduce the amount of time they have for active play, social contact with others and chances for language development
• affect the development of the full range of eye movement, and
• reduce the length of time they can stay focused.</td></tr>
<tr><td>For toddlers (one to three years)</td></tr>
<tr><td>For pre-schoolers (three to five years)</td><td colspan="5">Less than one hour of sedentary activity (such as watching TV) per day.</td></tr>
<tr><td>Resources available</td><td colspan="6">Sedentary Behaviour and Screen-Time
Get Up + Grow: Healthy Eating and Physical Activity for Early Childhood</td></tr>
<tr><td>How it is used</td><td colspan="6">Used by families and childcare professionals as a guide to activities with children.</td></tr>
<tr><td>Evaluation</td><td colspan="6">None.</td></tr>
</table>

CANADA: Canadian Sedentary Behaviour Guidelines for the Early Years (aged 0-4 years)					
Organisation	Canadian Society for Exercise Physiology			**Year**	2012
Collaborators	ParticipACTION				
Overview	Caregivers should minimise the time infants, toddlers and pre-schoolers spend being sedentary during waking hours. This includes prolonged sitting or being restrained for more than one hour at a time. For those under two years, screen time (eg, TV, computer, electronic games) is not recommended. For children aged two to four years, screen time should be limited to under one hour per day; less is better.				
Target population	From birth to aged 4.99 years				
Advice	**Age**	**Type and intensity**	**Context**	**Duration**	**Frequency**
	For infants (birth to one year)	Caregivers should minimise the time infants and toddlers spend during waking hours this includes prolonged sitting or being restrained (eg, stroller, high chair) for more than one hour at a time For those under two years, screen time (eg, TV, computer, electronic games) is not recommended.			
	For toddlers (one to three years)				
	For pre-schoolers (three to five years)	For children aged two to four years, screen time should be limited to under one hour per day.			
Resources available	Canadian Sedentary Behaviour Guidelines for the Early Years (0-4 years) Canadian Sedentary Behaviour Guidelines for the Early Years (0-4 Years): Clinical Practice Guideline Development Report				
Development of guidelines	Guidelines developed through literature review for the effects of PA on infants, toddlers and pre-schoolers which included at least one health variables (adiposity, bone and skeletal health, motor skill development, psychosocial health, cognitive development and cardio-metabolic indicators) as well as statistical analysis.				
How it is used	Used by families and childcare professionals as a guide to activities with children.				
Evaluation	None.				

APPENDIX D

SURVEY RESULTS

Appendix D describes the results of the stakeholder survey on users' experiences with the Active Movement resources. The survey aimed to create a snapshot of opinion-based information on stakeholders' views on the range of existing Active Movement resources and possible areas for improvement. It covered:

- Knowledge of existing Active Movement resources
- Previous and current use of existing Active Movement resources (eg, frequency of use, in what circumstances and with whom, for what purpose or whether practice changes occurred following the receipt of advice) and if not, why not
- Use of other resources (including what else is used and why Active Movement resources were not used)
- Perceptions about clarity and usability of the existing Active Movement resources content and formats (including what works and what does not, what could be improved), and
- Demographic information.

D.1 Structure of Appendix D

Key findings are presented first, followed by a discussion including description of the limitations of the body of evidence covered. Appendix D contains the following key findings sections:

- Profile of survey respondents
- Awareness of the Active Movement resources
- Use of the Active Movement resources
- Other resources used, and
- Future directions.

Information about the implications of the survey findings for the review of Active Movement resources is provided in the body of the main report.

A detailed description of the methodology for this survey is provided in Appendix A.

D.2 Response rate

A total of 267 stakeholders responded to the survey. Of these, 225 responses were fully completed. These responses form the bulk of responses discussed in this Appendix.

The remaining 42 responses were only partially completed. Most of the partially completed responses drop off early in the survey occurred (i.e., within the first nine questions generally). Table M and Table N (overleaf) illustrate at which question partial responses dropped out of the survey.

The manner in which the survey was deployed, meant that non-responders cannot be measured.

Table M: Question at which drop-off occurred for incomplete responses

Question number and content		Number of responses that dropped off
1-5	Questions about the respondent	13
6	Question about overall awareness of Active Movement resources	3
7	Question about awareness of specific Active Movement resources	4
8	Question about overall use of Active Movement resources	8
9	Question about last use of Active Movement resources	3
10-19	Questions about experience using Active Movement resources	4
20-26	Questions about future requirements	7

One-third of the respondents drop out of the survey at the questions regarding demographics. The remaining respondents drop out at different parts. Where possible, their responses have been included in the analysis. Beyond Question 9 it becomes problematic to compare the complete and incomplete response as the incomplete responses diminish. One of the possible explanations for not completing the survey beyond Question 9 may be that those respondents do not use the Active Movement resources (thereby limiting the level of interest in completing this survey).

Table N: Summary of incomplete responses' interaction with the resources

Number of respondents who were unaware of the Active Movement resources	Number of respondents who were aware of Active Movement resources but do not use them	Number of respondents who use Active Movement resources
4	7	13

D.3 Profile of respondent

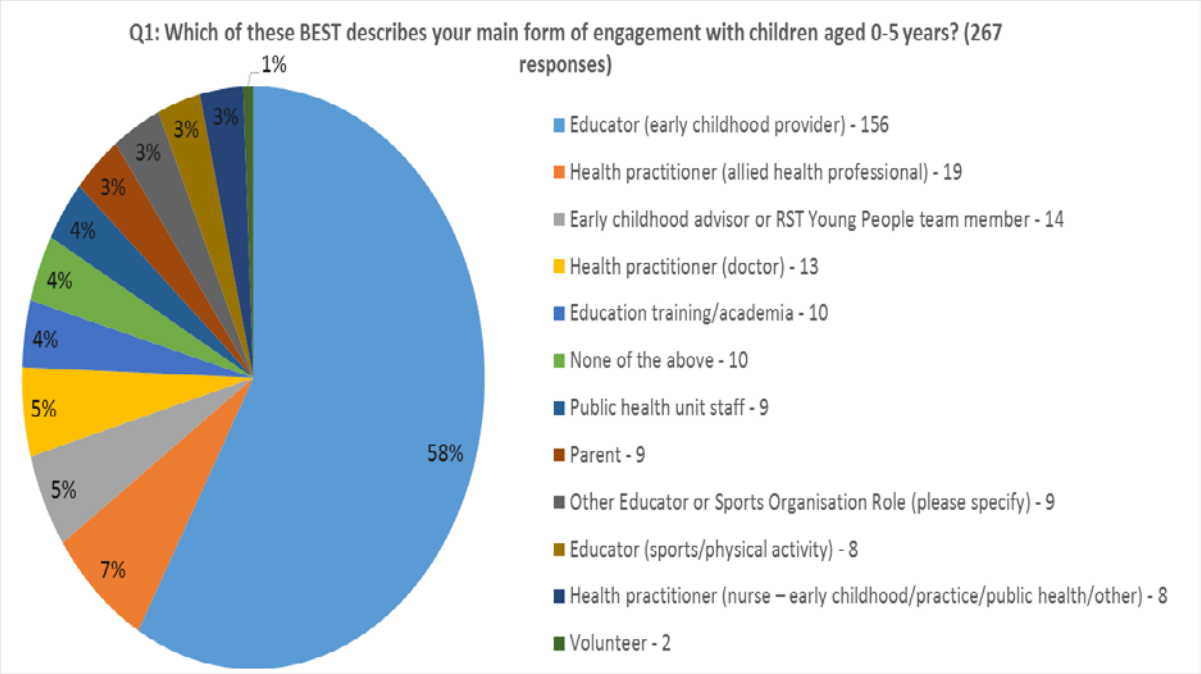
Respondents were asked a range of questions about who they are and the children they work with. This information helped us to determine whether a broad cross-section of possible Active Movement resource users (or non-users) completed the survey.

D.3.1 Main form of engagement with very young children

Question 1 asked respondents to describe their main form of engagement with children aged from birth to five years. The form of engagement was sought to ensure the survey covered a number different stakeholders and is used in the analysis to compare trends across different categories of Active Movement resources users or non-users.

Responses were received for all engagement forms, as described in Figure 2 (below). The largest proportion of respondents came from the early childhood education sector, followed by responses from RSTs. Not all RSTs responded to the survey[9].

Figure 2: Main form of engagement with children aged 0-5 years (all respondents)



No respondents initially identified with the answer category 'Sport Development officer at a National Sport Organisation (NSO)'; however, one respondent identified as an "Education Manager Swimming New Zealand". This response was classed as fitting into the NSO category and was therefore transferred into that category.

[9] Completed responses from RSTs were received from Auckland, Waikato, Bay of Plenty, Whanganui/Central North Island, Wellington/Wairarapa, Nelson/Marlborough and Otago. Partial responses were supplied from the Bay of Plenty and Otago. Some RSTs provided more than one completed or partially completed response.

Those who did not complete the survey show a similar profile to those who did fully completed it.

D.3.2 Location

Questions 2 and 3 asked respondents to describe the region in which they mostly work.

Respondents come from all areas of New Zealand (except the West Coast), and the proportions generally reflect what one would expect from a national survey (see Table O below). For the Lakes and Gisborne/Tairawhiti regions only one respondent for each region was received.

Respondents' main region of work information was complemented by information on whether the respondents identified the area in their region as urban or rural. Around 85 percent of respondents identified their area as urban. This matches with data from Statistics New Zealand about the relative spread of urban/rural residents[10].

Table O: Region where respondents mostly work (all respondents)

Region	Number of responses	Percent
Northland	11	4.12
Auckland	90	33.71
Waikato	7	2.62
Bay of Plenty	18	6.74
Lakes	1	0.37
Gisborne/Tairawhiti	1	0.37
Hawkes Bay	6	2.25
Taranaki	4	1.5
Whanganui/Central North Island	5	1.87
Manawatu/Horowhenua	21	7.87
Wellington/Wairarapa	26	9.74
Nelson/Marlborough	14	5.24
West Coast	0	0
Canterbury/South Canterbury	32	11.99
Otago	21	7.87
Southland	10	3.75
Total	**267**	**100**

D.3.4 Ethnicity of people that respondents work with

[10] www.stats.govt.nz/browse_for_stats/population/Migration/internal-migration/urban-rural-migration.aspx

Respondents were asked to identify which ethnicities they work and which ethnicities they work with the most in order to understand who the ultimate recipients of the Active Movement advice are.
Ethnicity results indicate that the survey includes responses from a wide range of New Zealanders and, broadly, the ethnicity profile of survey respondents matches the New Zealand population's ethnicity profile. Most commonly, respondents work with:

1. New Zealand European/Pakeha (identified by 95 percent of respondents)
2. and Māori children (identified by over 80 percent of respondents)
3. Samoan' and Asian children (identified by approximately 60 percent of respondents), and/or
4. Tongan, Other Pacific ethnicity, and Middle Eastern, Latin American, African children (identified by approximately 40 percent of respondents).

Table P: Ethnic groups that respondents work with

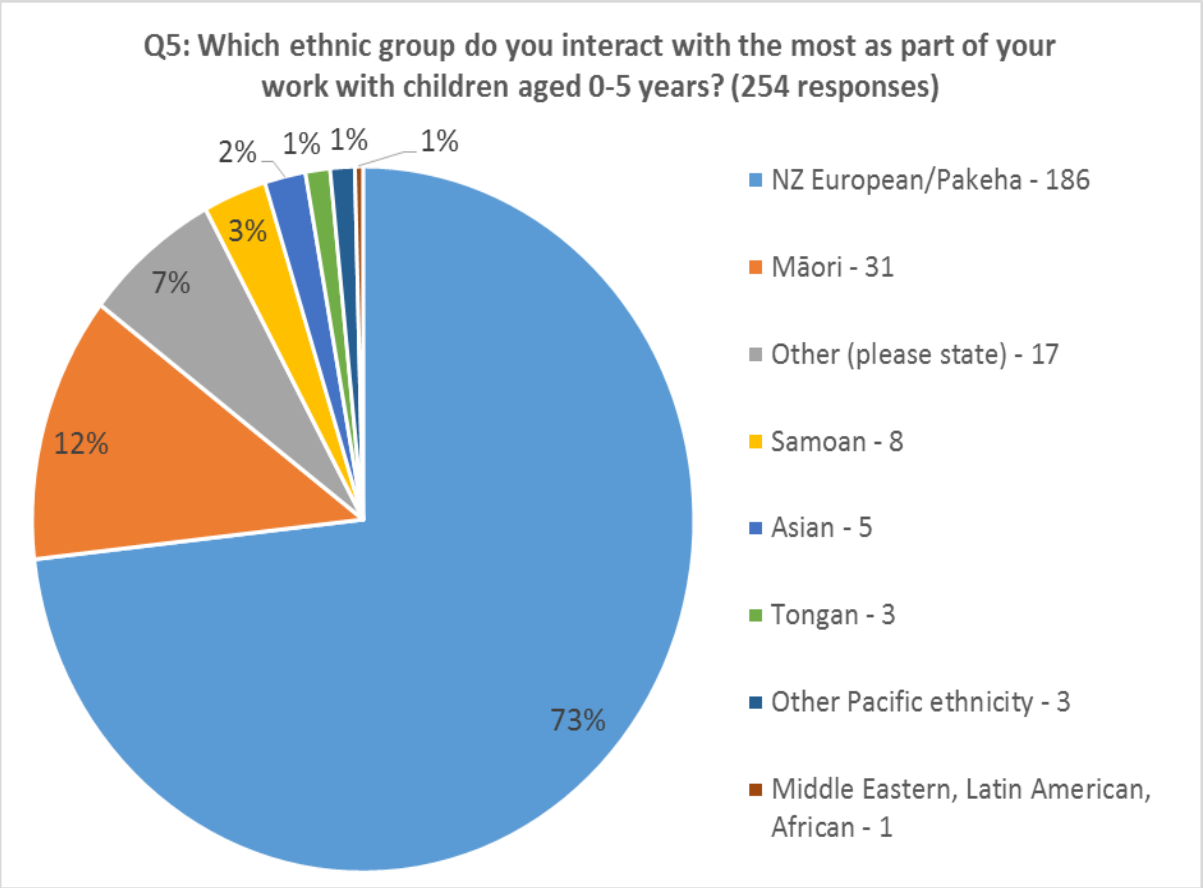
Ethnicity	Responses	Percentage
New Zealand European/Pakeha	241	94.88
Māori	208	81.89
Samoan	143	56.3
Tongan	106	41.73
Other Pacific ethnicity	103	40.55
Asian	152	59.84
Middle Eastern, Latin American, African	99	38.98
Other (eg, Indian, Nepalese, European or South African)	39	15.35

When asked to indicate the ethnicity that the respondent works with the most, most respondents indicated 'New Zealand European/Pakeha'. Again, this matches well with the Statistics New Zealand data stating that 74 percent of the New Zealand population identify as New Zealand European/Pakeha[11]. The other ethnicities were similar to the Statistics New Zealand data, except for Asian which was significantly lower than the population level. Those who responded in the free text answer 'Other' generally stated (in a manner of phrases) they worked with all ethnicities evenly (n=13/6) or that they worked with all Pacific ethnicities (n=2/16) or Māori and Pacific ethnicities (n=1/16).

Detailed responses to this question are provided in Figure 3 (overleaf).

[11] ww.stats.govt.nz/Census/2013-census/profile-and-summary-reports/infographic-culture-identity.aspx

Figure 3: Ethnic group that respondents work with the MOST

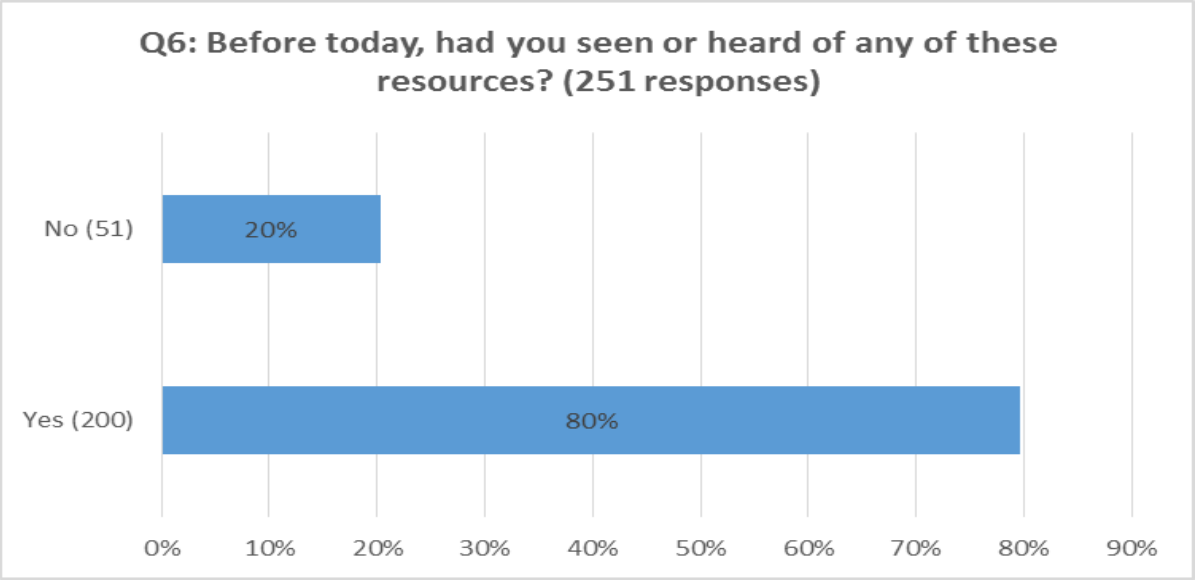


D.4 Awareness of the Active Movement resources

Respondents were asked a range of questions about their current awareness of the Active Movement resources. Assessing whether respondents had seen or heard of the Active Movement was the first question used to filter respondents. Awareness indicated how prominent the resources still are considering the production and promotion was initiated in 2003.

Specifically, respondents were asked whether they had seen or heard of the Active Movement resources prior to undertaking the survey (i.e., Question 6). The majority of respondents were aware of the Active Movement resources: 80 percent answered yes to this question. All RST respondents were aware of the resources. The full results to this question are set out in Figure 4 (overleaf).

Figure 4: Graph of respondents awareness of the Active Movement resources



Respondents who had not seen or heard of the Active Movement resources prior to undertaking the survey (n = 51) included a higher than expected proportion of health practitioners, with half of doctor (n= 7) respondents being unaware of the resources. Other types of health practitioners did not show this same spike as doctors.
There appear to be regional variations in the level of awareness of the Active Movement resources. For example:

- Respondents who identified as mainly working in Northland (n=11), Gisborne/Tairawhiti (n=1), Whanganui/Central North Island (n=5), Otago (n=20) and Southland (n=10) were more likely to be aware of the resources, and
- Respondents who identified as mainly working in the 'Bay of Plenty' and the 'Lakes' regions were more likely to be unaware of the resources (i.e., 38 percent of respondents from Bay of Plenty and all Lakes respondents), although these variations are most likely a reflection of small numbers of respondents from these areas: we do not think there is an awareness issue that is particular to those areas.

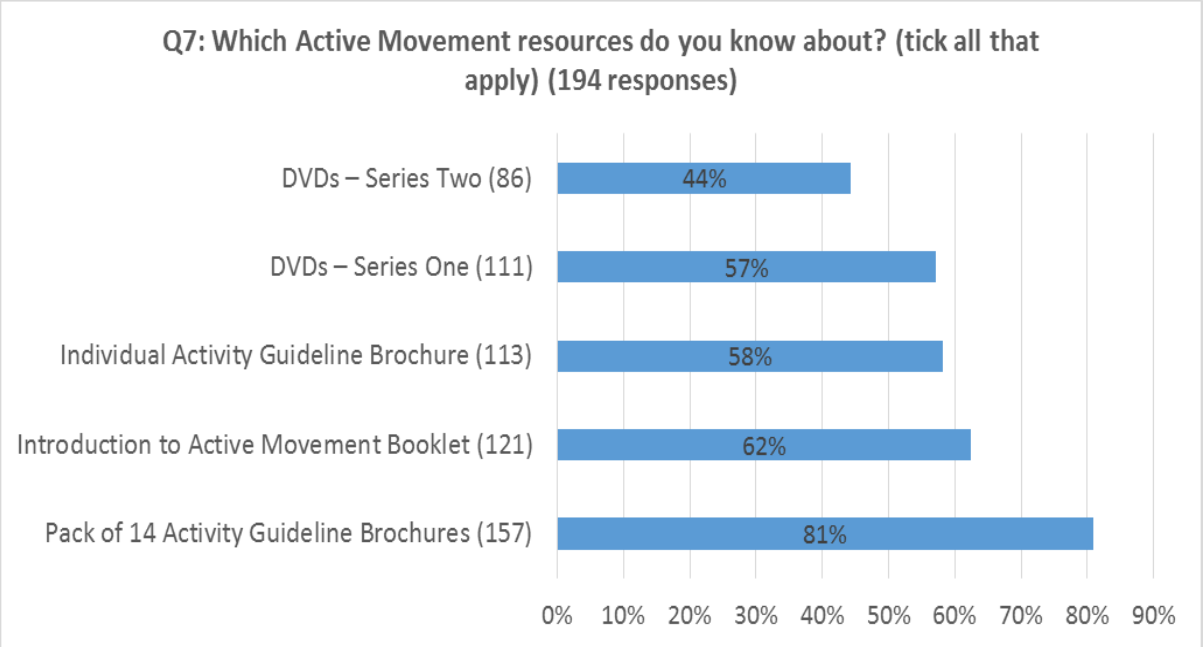
There were also some differences in level of awareness by an analysis of the way that respondents identified the ethnicities who they worked with the most. Those who identified working mostly with Māori (38 percent; n=8), Samoan (37 percent; n=3), and Other (47 percent; n=8) were more likely to be unaware of the resources. Again, this variation could be explained by very small numbers rather than perhaps reflecting an awareness issue based on ethnicity.

When asked which of the Active Movement resources they were aware of (i.e., question 7), generally respondents had seen or heard of all of them, as described in Figure 5 (overleaf). Most commonly, respondents were aware of the 'Pack of 14 Activity Guideline Brochures' (approximately 80 percent of respondents identified that they had seen or heard of these resources and 58 percent had heard of the individual brochures). The 'DVDs – Series One', 'Individual Activity Guideline Brochure' and

'Introduction to Active Movement Booklet' were less well-known with between 57 and 62 percent of respondents aware of these resources. Less than half of respondents were aware of 'DVDs – Series Two'.

There was no discernible difference in pattern of awareness for those who used the resources and those that did not, although those who did not use the resources were, overall, less aware of the Active Movement resources as all resources for the group were below 40 percent in terms of responses (with the exception of the brochures).

Figure 5: Respondents' awareness of specific Activement Movement resources



D.5 Use of the Active Movement resources

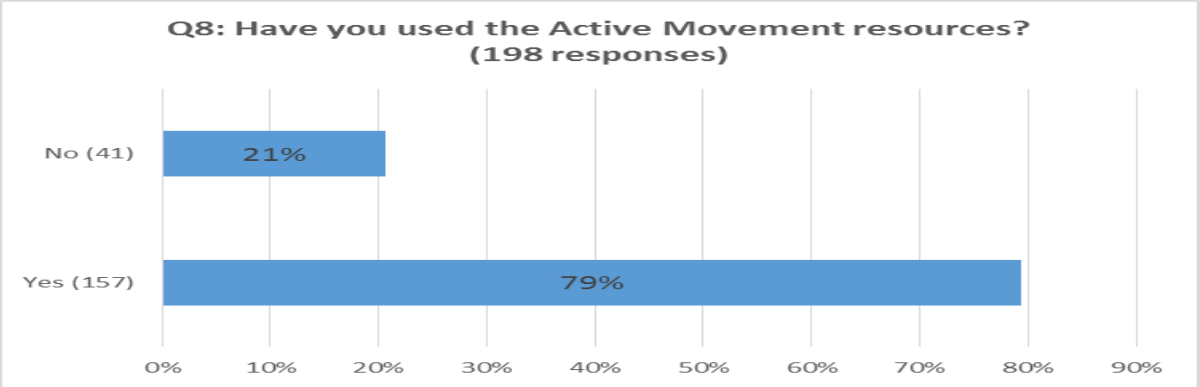
Respondents were asked whether they use the Active Movement resources. Depending on their response (i.e., yes or no), they were then asked further questions about why they use them and their experiences with specific Active Movement resources. Understanding if and how the resources are used (including whether they are currently in use) provides useful information about if the resources are valued and what users may wish to see retained, should any update be required.

Respondents were asked if they have ever used the Active Movement resources and, if so, when they last used the resources.

D.5.1 Overall use, including currency of use

The majority of respondents (79 percent) who were aware of the Active Movement resources also used them (i.e., question 8), as described in Figure 6 (overleaf).

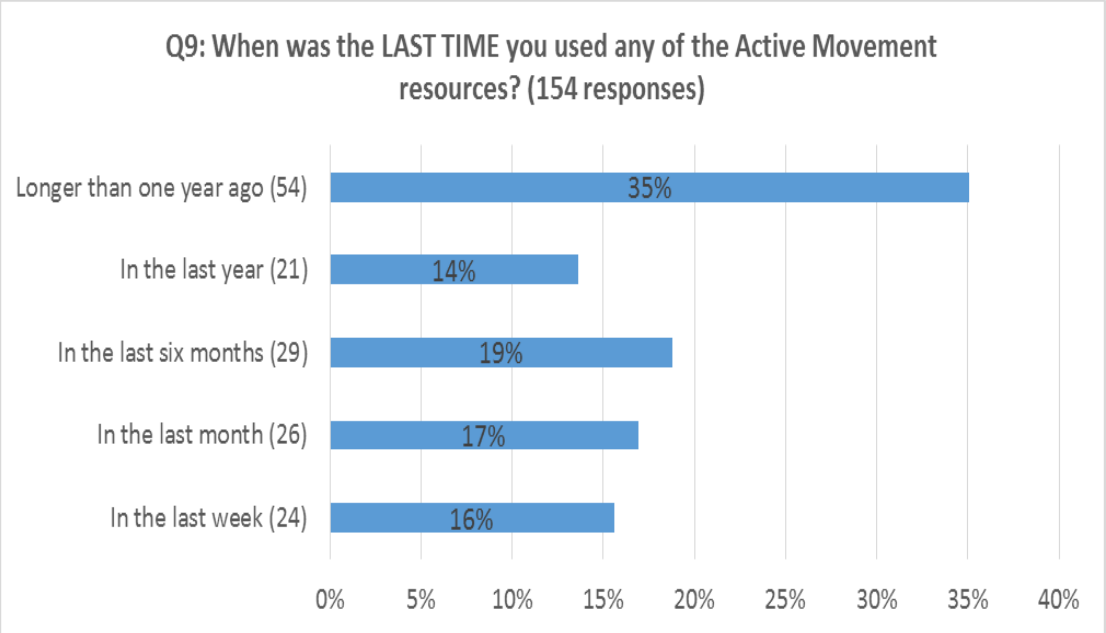
Figure 6: Use of the Active Active Movement resources



We completed an analysis to see if there were groups of respondents who are aware of the Active Movement resources but do not use them. Only a very small number of respondents in these groups (n=<10) were identified. Such a small number tells us little about whether different groups of respondents are more likely to know about but not use the resources.

More information about the reasons why stakeholders do not use the Active Movement resources is provided in the Reasons for not using the resources section. Information on the overall use of the Active Movement resources was complemented with information around the timing of the last use (i.e., question 9). Responses to this question are described in Figure 7 (below).

Figure 7: Timing of last use of the Active Movement resources



The Active Movement resources are currently in use, with 51 percent of respondents indicating that they have used them within the previous six months, and 15 percent having used the Active Movement resources within the last week; however one-third

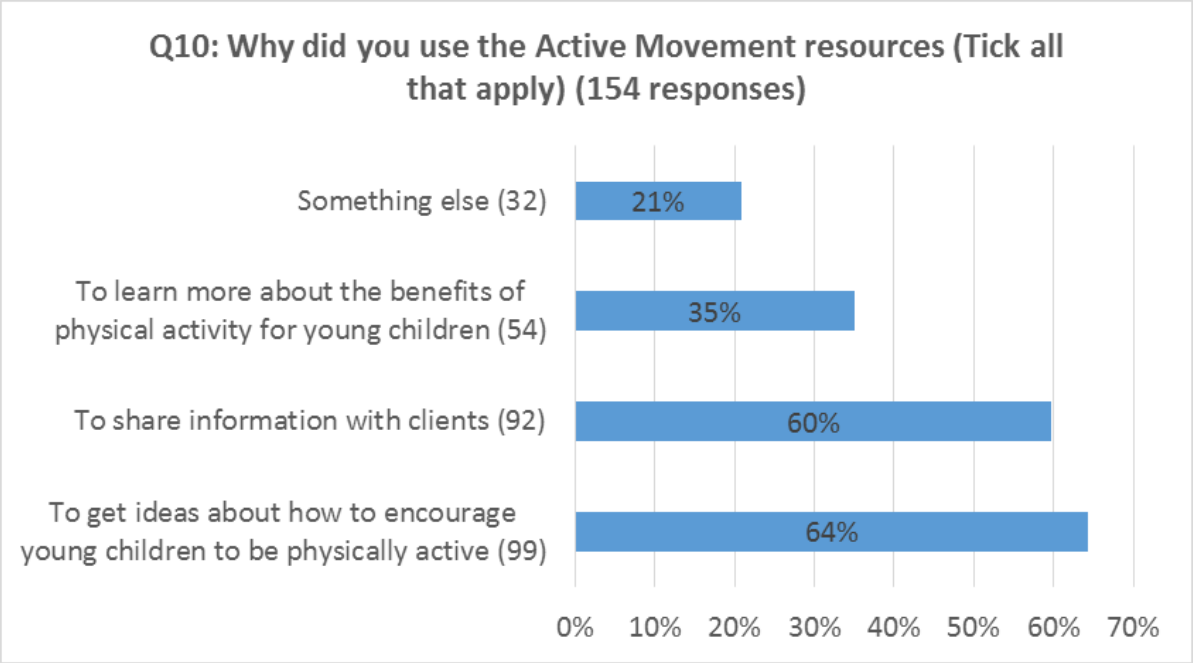
of the resource users have not used them within the last year. It is not clear from the findings as to why respondents have stopped using the Active Movement resources.

D.5.2 Why do users use the Active Movement resources?

Respondents were asked to identify why they use the Active Movement resources (i.e., question 10). They were provided with three options as well as a free-text option. The responses to this question are described in Figure 8 (below).

Generally, respondents identified with the provided responses (i.e., they use the Active Movement resources to share information and to get ideas about encouraging young children to be active and, less commonly, to learn about the benefits of PA for young children).

Figure 8: Reasons for using the Active Movement resources



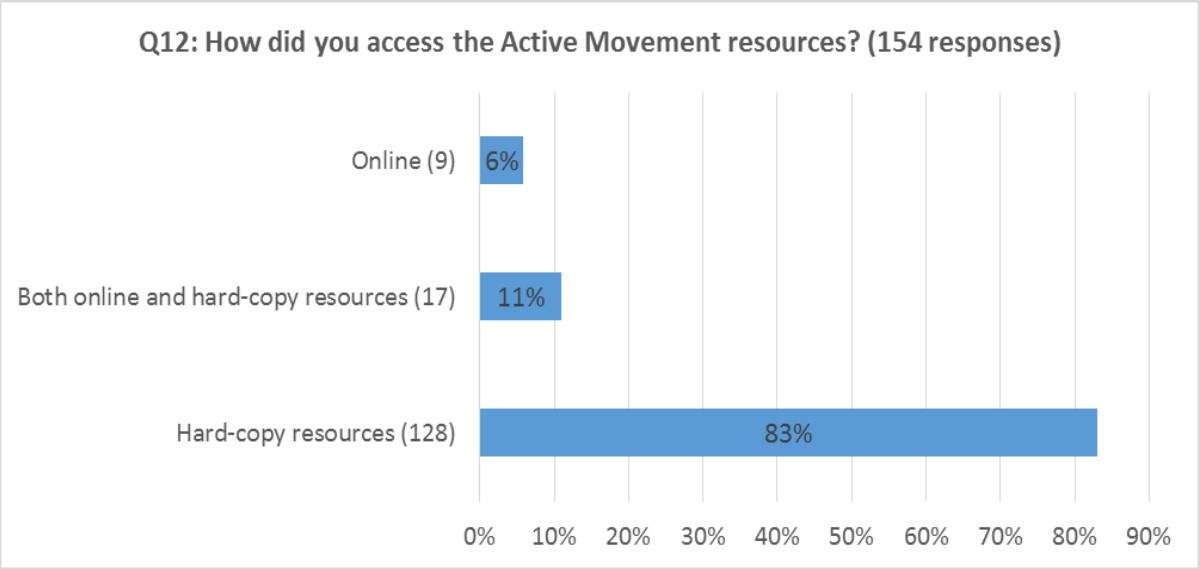
Other reasons proffered included that:

- They attended workshop where the Active Movement resources were used (n=4)
- Improve children's muscle strength and body coordination (n=2)
- There is limited other resources available (n=1)
- Given resource (n=1)
- As a means to document support for PA in improving education outcomes (n=1), and
- Passionate about movement (n=1).

D.5.3 Access to resources

Stakeholders were asked how they accessed the Active Movement resources (i.e., question 12). Their responses are described in Figure 9 (overleaf). Over 80 percent of respondents accessed the resources as 'hard-copy resources'. Only a very small number of respondents identified as accessing online (n = 9) and the remainder said that they access using both channels (n = 17).

Figure 9: How respondents accessed the Active Movement resources

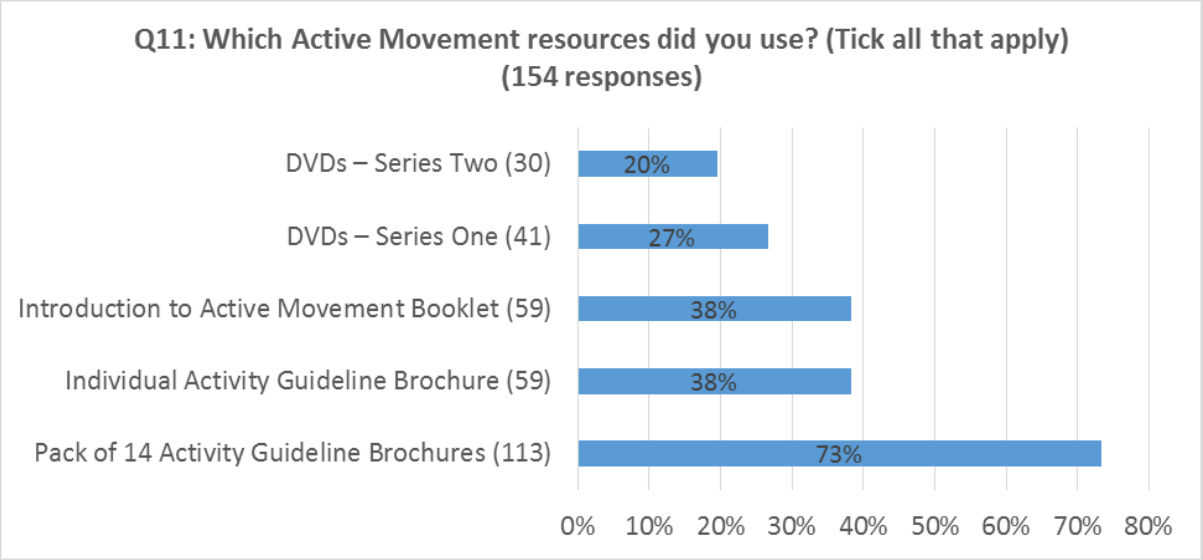


D.5.4 Which resources are used?

To complement the information around overall use of the resources, respondents were asked about which specific resources were used (i.e., question 11). Stakeholders were then asked to rate the frequency of use, usefulness, ease of understanding, ease of use, accessibility, suitability of each resource that they indicated that they used.

All the resources are used to some degree although clearly some are used more frequently than others, as described in 10 (overleaf). These results showed a similar pattern to the results around awareness of the resources. For example, the 'Pack of 14 Activity Guideline Brochures' is used more than other resources, with 73 percent of respondents using this resource compared to 80 percent of respondents having an awareness of this resource.

Figure 10: Respondents' use of specific Activement Movement resources



D.5.5 Satisfaction with the resources used

Following on from Question 11, the survey then asked respondents to think about their level of satisfaction with the Active Movement resources, based on the following variables: frequency of use, usability, format, and suitability.

How respondents responded to question 11 was significant, as this information was used to filter results in regards to questions 13, 14, 15, 16, and 18 (i.e., the following analysis for questions 13-16 and 18 includes responses only where the respondent identified the use of a particular resource). The number of respondents by resource use is described in Table Q (overleaf).

The following section describe only responses from those respondents who indicated that they used a particular resource and who then commented on questions 13-17 (i.e., "the number of respondents who use this resource" column in Table Q). The column "Total number of respondents who rated this resource" includes all of the respondents who indicated that they used a specific resource (i.e., Group A) and all of those who commented on a resource but who did not indicate that they used that particular resource (i.e., Group A + Group B).

Table Q: Number of respondents who use specfic Active Movement resources

Active Movement resource	Number of respondents who use this resource	Total number of respondents who rated the resource
DVDs – Series One	41	126
DVDs – Series Two	30	117
Activity Guidelines Brochure (either the pack of 14 or individual brochures)	143	144
Introduction to Active Movement Booklet	59	134

Frequency of use by Active Movement resource

If respondents used specific Active Movement resources, they were asked to identify how frequently they did so (i.e., Question 13). Specific responses to this question are described in Table R (below).

Generally, all resources are used reasonably frequently (for example, DVDs used always or often 43 percent of responses, and the booklet and brochures are used always or often by 36 percent of the respondents). Occasional use appears to be the most common frequency that users use the Active Movement resources. Few respondents indicated that they never use the resources.[12]

Table R: Frequency of use for specific Activement Movement resources

Resource	Always	Often	Sometimes	Never	Do not know or unsure	Total number of respondents
DVDs – Series One	**7.32%** 3	**36.59%** 15	**53.66%** 22	**0.00%** 0	**2.44%** 1	**41**
DVDs – Series Two	**6.67%** 2	**36.67%** 11	**53.33%** 16	**0.00%** 0	**3.33%** 1	**30**
Activity Guidelines Brochure	**7.41%** 10	**28.89%** 39	**55.56%** 75	**4.44%** 6	**3.70%** 5	**135**
Introduction to Active Movement Booklet	**.08%** 3	**35.59%** 21	**59.32%** 35	**0.00%** 0	**0.00%** 0	**59**

[12] The unfiltered data indicates a difference for both DVDs series, with a high proportions of respondents indicating that they never or only sometimes use the DVDs.

Meeting needs

If respondents used specific Active Movement resources, they were asked to identify whether that resource met their needs (i.e., question 14). Table S (below) illustrates how the resources met the respondents' needs. It shows that all of the resources meet respondents' needs most of the time. Few respondents indicated that the resources do not fit their needs.[13]

Table S: How specific Activement Movement resources meet needs

Resource	Very well	Mostly	Somewhat	Not at all	Do not know or unsure	Total number of respondents
DVDs – Series One	**35.00%** (n = 14)	**35.00%** (n = 14)	**27.50%** (n = 11)	**0.00%** (n = 0)	**2.50%** (n = 1)	**40**
DVDs – Series Two	**44.83%** (n = 13)	**34.48%** (n = 10)	**20.69%** (n = 6)	**0.00%** (n = 0)	**0.00%** (n = 0)	**29**
Activity Guidelines Brochure	**29.01%** (n = 38)	**41.22%** (n = 54)	**24.43%** (n = 32)	**0.76%** (n = 1)	**4.58%** (n = 6)	**131**
Introduction to Active Movement Booklet	**39.66%** (n = 23)	**41.38%** (n = 24)	**15.52%** (n = 9)	**1.72%** (n = 1)	**1.72%** (n = 1)	**58**

Ease of use and understanding

If respondents used specific Active Movement resources, they were asked how easy the resources were to understand and use (i.e., question 15 and 16). Respondents found that all of the Active Movement resources were predominantly very easy or mostly easy to understand. No respondents identified any of the resources as difficult to understand.[14] For example:

- DVDs very easy and mostly easy to understand: 92 percent of responses
- Brochures very easy and mostly easy to understand: 90 percent of responses, and
- Booklet very easy and mostly easy to understand: 92 percent of responses.

[13] The unfiltered data indicates a difference for both of the DVDs series, this may reflect those unfiltered respondents who stated in the previous question (question 13) that they 'Never' use the DVDs. Uncertainty was also noted with the 'Introduction to Active Movement Booklet' for unfiltered responses.

[14] The unfiltered responses indicates a difference in the 'Do not know/Unsure' category for both of the DVDs series, this may reflect those respondents who stated in question13, they 'Never' use the DVDs.

Specific results are described in Table T (overleaf).

Table T: How easy are the Active Movement resources to understand?

Resource	Very easy	Mostly easy	Somewh at easy	Difficult	Do not know or unsure	Total number
DVDs – Series One	**70.00%** (n = 28)	**22.50%** (n = 9)	**7.50%** (n = 3)	**0.00%** (n = 0)	**0.00%** (n = 0)	**30**
DVDs – Series Two	**75.86%** (n = 22)	**17.24%** (n = 5)	**6.90%** (n = 2)	**0.00%** (n = 0)	**0.00%** (n = 0)	**29**
Activity Guidelines Brochure	**62.31%** (n = 81)	**28.46%** (n = 37)	**5.38%** (n = 7)	**0.00%** (n = 0)	**3.85%** (n = 5)	**130**
Introduction to Active Movement Booklet	**63.79%** (n = 37)	**29.31%** (n = 17)	**6.90%** (n = 4)	**0.00%** (n = 0)	**0.00%** (n = 0)	**58**

The vast majority of respondents who identified using a specific Active Movement resource also found that the specific resource was very easy to use:

- DVDs very easy and mostly easy to use: 90 percent of responses
- Brochures very easy and mostly easy to use: 90 percent of responses, and
- Booklet very easy and mostly easy to use: 96 percent of responses.

Only one respondent identified any of the resources as difficult to use.[15]

[15] The unfiltered responses indicates a difference in the 'Do not know/Unsure' category for both of the DVDs series again, this may reflect those respondents who stated in question13, they 'Never' use the DVDs.

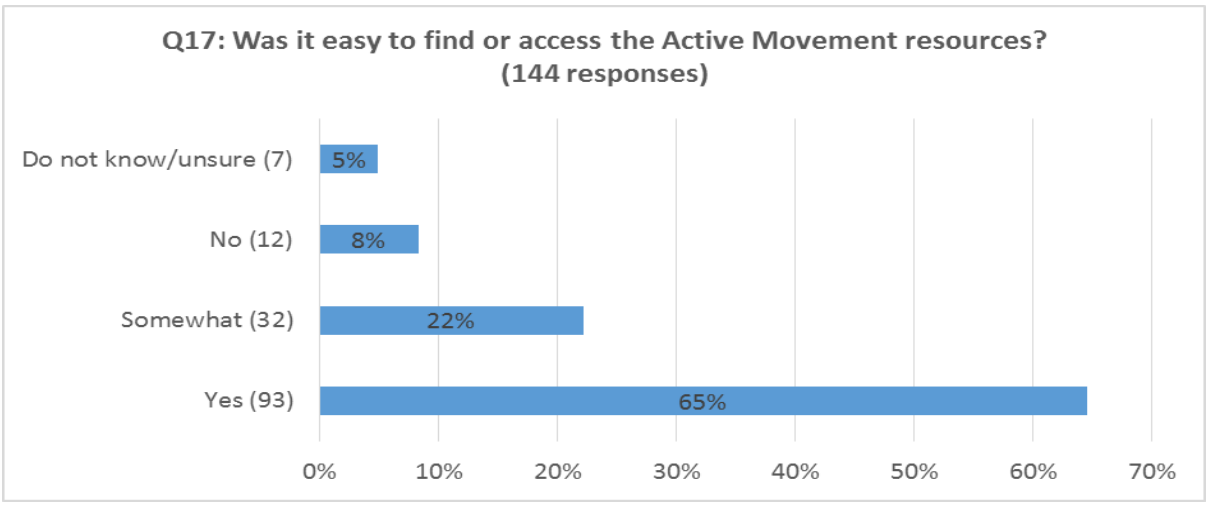
Table U: How easy are the Active Movement resources to use?

Resource	Very easy	Mostly easy	Some-what easy	Difficult	Do not know or unsure	Total number
DVDs – Series One	**62.50%** (n = 25)	**27.50%** (n = 11)	**7.50%** (n = 3)	**2.50%** (n = 1)	**0.00%** (n = 0)	**40**
DVDs – Series Two	**65.52%** (n = 19)	**27.59%** (n = 8)	**6.90%** (n = 2)	**0.00%** (n = 0)	**0.00%** (n = 0)	**29**
Activity Guidelines Brochure	**60.00%** (n = 78)	**30.00%** (n = 39)	**5.38%** (n = 7)	**0.00%** (n = 0)	**4.62%** (n = 6)	**130**
Introduction to Active Movement Booklet	**62.07%** (n = 36)	**34.48%** (n = 20)	**3.45%** (n = 2)	**0.00%** (n = 0)	**0.00%** (n = 0)	**58**

Access

When asked about access to the resources, all respondents who used a specific Active Movement resources identified that they were clearly easy to find or access (i.e., responses to Question 17), as described in Figure 11 (below).

Figure 11: Respondents' views on how easy it is to find the resources



Suitability

If respondents used a specific Active Movement resource, they were asked whether the format of the resources was suitable (i.e., question 18). Generally respondents found the Active Movement resources suitable:

- DVDs very and mostly suitable (75 percent of responses)
- Brochures very and mostly suitable (80 percent of responses), and
- Booklet very and mostly suitable (81percent of responses).

Very few respondents identified the resources as not suitable (n=2).[16]

The specific data for responses to this question can be found in Table V (below).

Table V: Suitablility of specific Activement Movement resources

Resource	Very suitable	Mostly suitable	OK	Not suitable	Do not know or unsure	Total number
DVDs – Series One	**50.00%** (n = 20)	**25.00%** (n = 10)	**20.00 %** (n = 8)	**2.50%** (n = 1)	**2.50%** (n = 1)	**40**
DVDs – Series Two	**51.72%** (n = 15)	**31.03%** (n = 9)	**17.24 %** (n = 5)	**0.00%** (n = 0)	**0.00%** (n = 0)	**29**
Activity Guidelines Brochure	**45.04%** (n = 59)	**35.88%** (n = 47)	**15.27 %** (n = 20)	**0.00%** (n = 0)	**3.82%** (n = 5)	**131**
Introduction to Active Movement Booklet	**46.55%** (n = 27)	**41.38%** (n = 24)	**8.62 %** (n = 5)	**1.72%** (n = 1)	**1.72%** (n = 1)	**58**

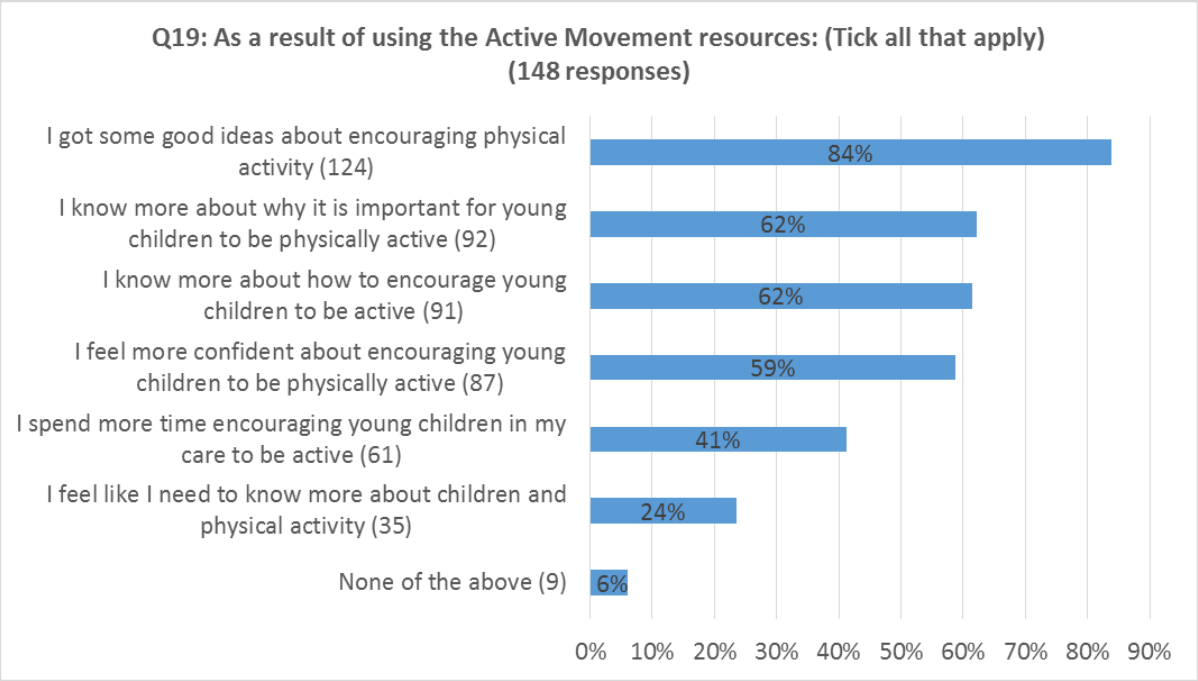
D.5.6 Outcomes associated with using the Active Movement resources

If stakeholders used the Active Movement resources, they were asked what resulted from their use (i.e., question 19). Respondents were provided with six options as well

[16] The unfiltered responses indicates a difference in the 'Do not know/Unsure' category for both of the DVDs series again, this may reflect those respondents who stated in question13, they 'Never' use the DVDs. Along with uncertainty noted with the 'Introduction to Active Movement Booklet' also.

as a free-text option. The responses to this question are described in Figure 12 (overleaf).

Figure 12: Percieved outcome of using the Activement Movement resources



In question 10, respondents identified as the main reason for their use of the Active Movement resources was to get ideas about how to encourage young children to be physically active. There is a strong correlation between the reason for using the Active Movement resources and the perceived outcomes associated with that use.

D.6 Reasons for not using the resources

To help understand why the Active Movement resources are not resources of first-choice for stakeholders, we asked those who said they did not use the resources about why. This information will help to describe how the resources may need to be improved in the future.

Respondents who identified that they were aware of the Active Movement resources but noted that they did not use them (n = 41), were asked to explain why they do not use them (i.e., the 41 responded who responded 'No' to Question 8 were directed to Question 20).

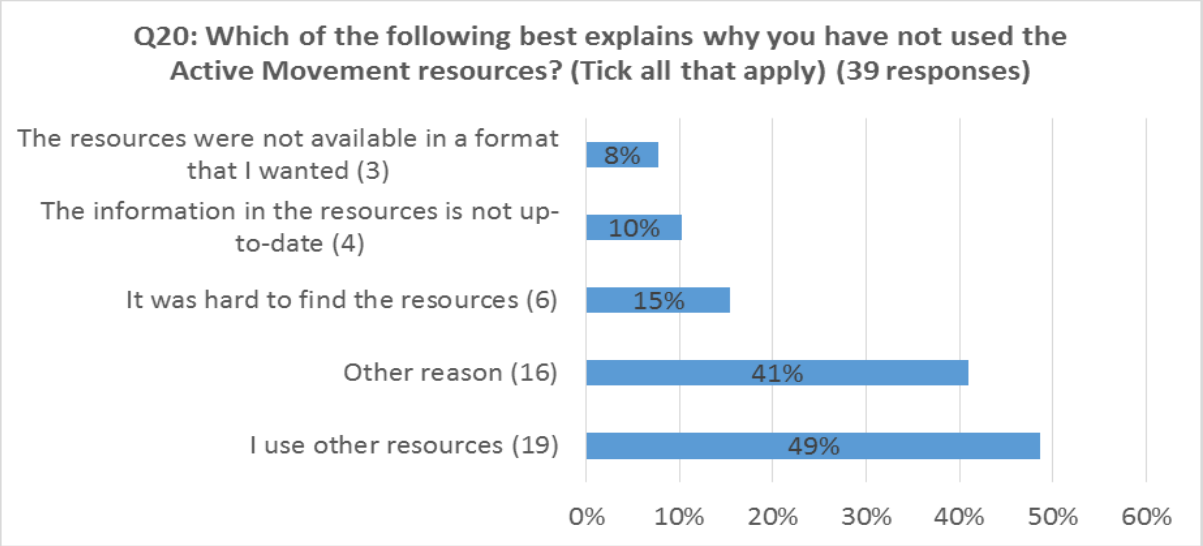
Respondents were provided with four options as well as a free-text option. The responses to this question are described in Figure 13 (overleaf). The main reasons for not using the Active Movement resources is that the respondent chooses to use other resources. The range of resources used is identified in questions 25 and 26.

Respondents were also able to provide other reasons for why they do not use the Active Movement resources.

Reasons proffered included that:

- The Active Movement resources are not required to do perform the current work role (n=5: this was a popular response among academics)
- The respondent was not aware of Active Movement resources or had forgotten about them (n=2)
- The current resources are not appealing (n=1), or
- There is no of Active Movement co-ordinator in area (n=1).

Figure 13: Respondents' reasons for not using the Active Movement resources



D.7 Thoughts on the future of the Active Movement resources

The penultimate section of the survey looked at how the Active Movement resources could be improved or what new resources need to include. Information regarding what respondents wanted in regards to content, format and accessibility was sought.

D.7.1 Content

Stakeholders were asked to describe the information that they would find useful in any new resources (i.e., Question 21). The responses are described in Figure 14 (overleaf). There is a high correlation between the kinds of information that respondents find useful and the information included in the current Active Movement resources. Other types of information was requested:

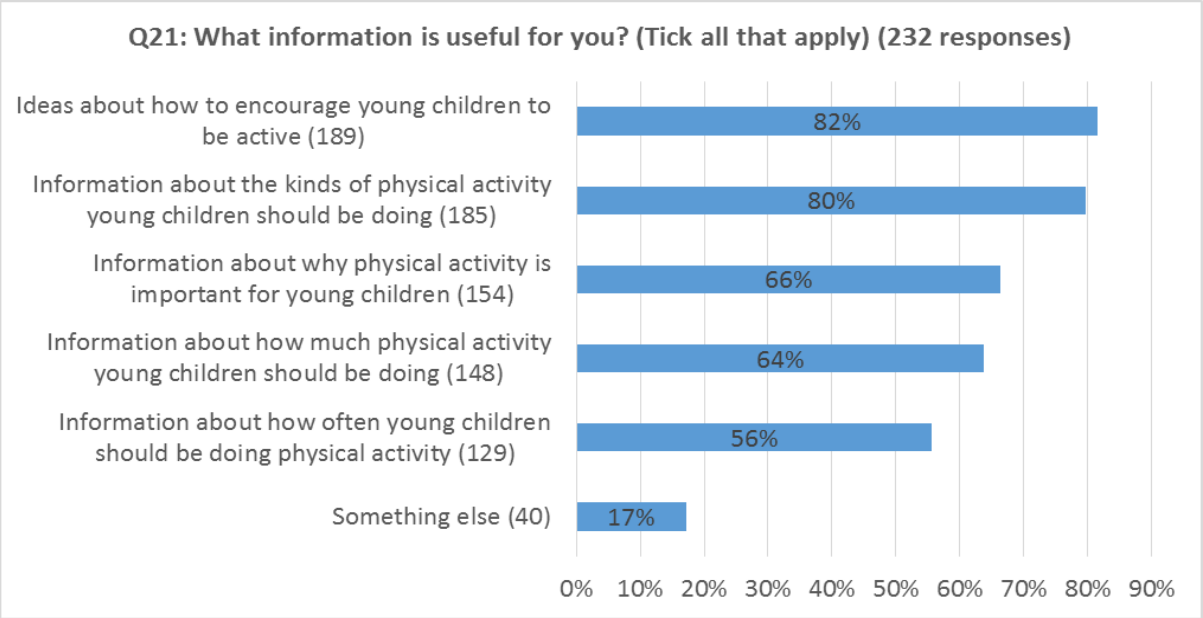
- Those who were unaware of the resources also wanted information about discouraging sedentary behaviour and information relating to activities for children with a disability.
- Respondents who were aware of the resources but did not use them wanted information about how families could be active together and information on how PA fits within health, nutrition, and other behaviours. Though one

submitter stated they just wanted "*creative physical game ideas, we know why just need more ideas*".

- For those that used the resources respondents wanted information about discouraging sedentary behaviour; information relating to activities for children with a disability; information about how families could be active together; information on how PA fits within health, nutrition, and other behaviours. Also mentioned was information targeted for grandparents.

Respondents wanted information in Te Reo but also a number of languages (none other than Māori specifically stated). Information regarding the long term benefits of PA and the benefit of PA and preparation for school was mentioned, along with information on where to purchase equipment.

Figure 14: What information is useful: <u>ALL</u> respondents?



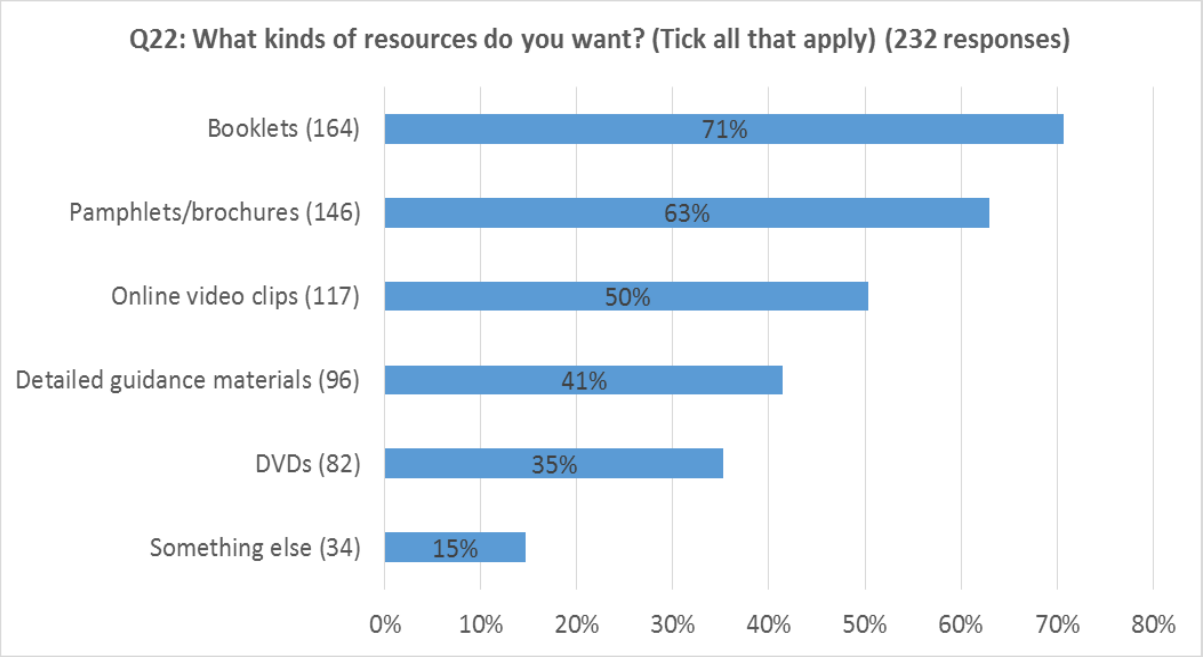
There is no difference in the results when separated by data sets (i.e., those who had not seen or heard of the resources, those who had seen and heard of the resources but do not use them, and those who use the resources).

D.7.2 Preferred type

When looking at what format the respondents wanted, the resources in generally respondents identified 'Booklets' then 'Pamphlets/brochures' as the kind of resource they wanted the most (question 22). These options were identified by roughly 70 percent and 60 percent of respondents respectively (as described in Figure 15 overleaf).

The main option mentioned by respondents in the 'Something else' field was increased ICT resources, in the form of phone or tablet apps, online resources, social media and/or interactive resources (although one caveat with this was that some respondents highlighted that some families struggle to access technology).

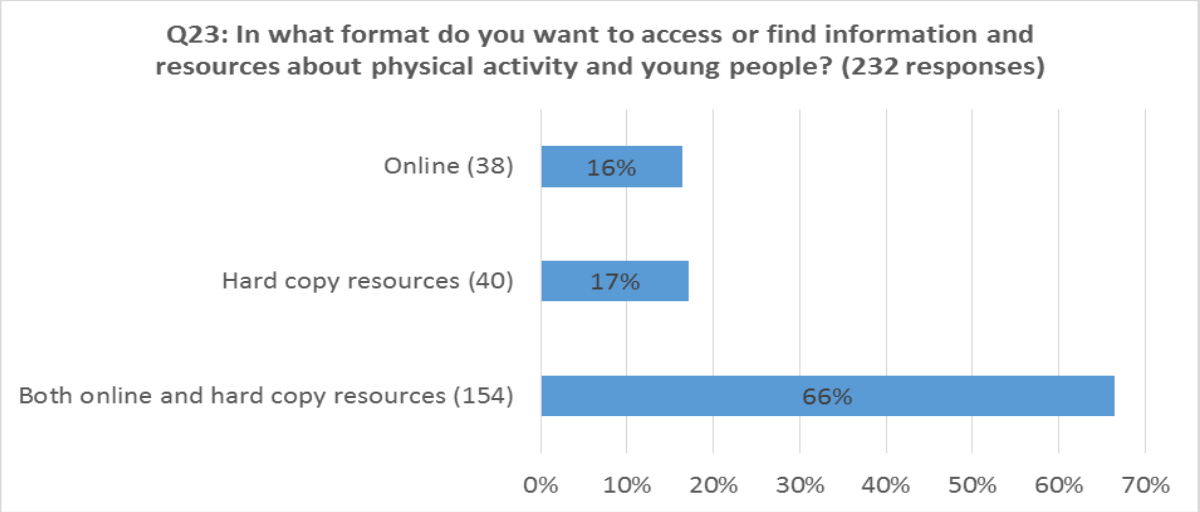
Figure 15: Preferred type



D.7.3 Preferred format

In terms of preferred format the majority of respondents wanted resources in both online and hard-copy formats (i.e., Question 23), as described in Figure 16 (below). The 'both' option was wanted by the majority regardless of they were aware of the current Active Movement resources or used them or not. For the respondents who used the resources this was a contrast to the results of question 12 (where the majority access the resources by hard copy). For those that were unaware and did not use the resources there was an increase in wanting the resources online but the 'both' option was still wanted by the majority.

Figure 16: Preferred format

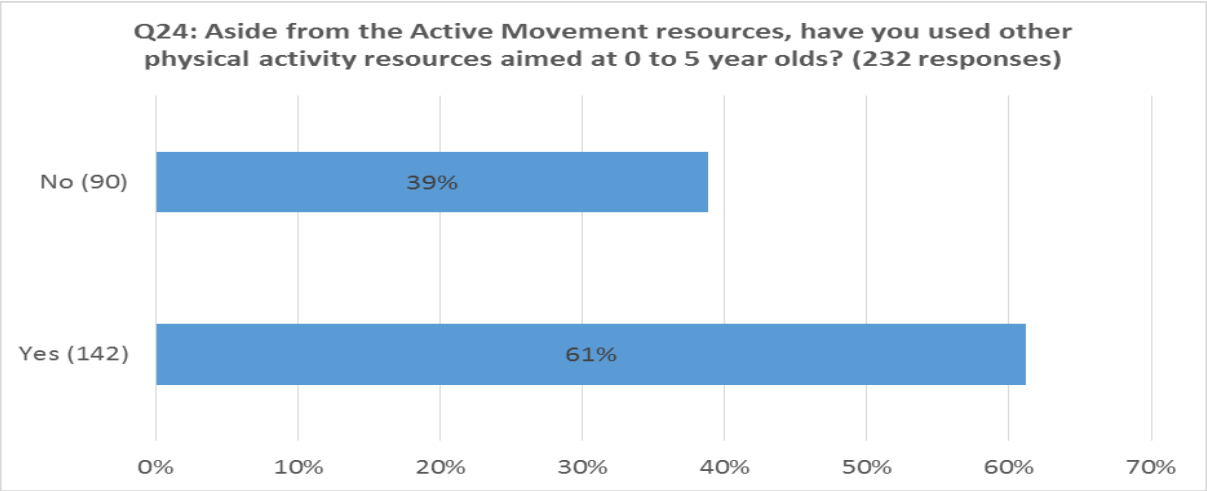


D.8 Knowledge and use of other resources

The Active Movement resources are not the only resources available for those seeking information of PA and FMS. The survey sought information on how many respondents used other resources, what those resources were and why they used those resources.

The majority of respondents had used other resources in the under fives PA space (as described in Figure 17, below).

Figure 17: Use of other resources



Across the data sets there were some marked differences:

- Respondents who use the Active Movement resources were more likely to also use other resources (i.e., 71 percent or 105 respondents who used the resources identified as having used other resources).
- If a respondent was unaware of the Active Movement resources, they were also less likely to use other PA resources aimed from birth to five year olds (i.e., only 35 percent or 17 respondents identified that they use other resources).
- Of respondents who were aware of the Active Movement resources but did not use them (those who answered no to question 8, n = 41), only three respondents used other resources.

A large number of alternative PA and FMS resources were identified (question 25) by respondents. This included:

- Various work by Gill Connell including *A moving child is a learning child*, *Moving to Learn*, *Moving Smart*, the perceptual motor programme: in total, 35 respondents mentioned Connell's work (NB Connell was mentioned across all the data sets including those unaware of the Active Movement resources, those who did not use the Active Movement resources and those that did)

- Resources created by the local RST or NSO examples included PlayGym (PlayGym resources was mentioned more than the other RST and NSO resources), Sport NZ's *Making bath time fun*, Counties Manukau's *Fundamental Movement Skills* and Sport Northland's Fundamental Fun.
- The PA and FMS guidelines of other countries examples were Canadian Sport for Life and National Association of Sport and Physical Education guidelines, and
- Resources from the New Zealand Heart Foundation.

Why respondents used other resources

The reasons why respondents used other resources (i.e., question 26), was numerous and varied though some themes did emerge. The main reason identified by respondents were that the other resources were appropriate for children. This meant they were described as fun, easy to use, interactive, included dance and music, age appropriate, targeted towards children, child friendly, bright and colourful. This theme was combined with other themes in many responses highlighting that respondents felt the resources should be targeted or appropriate for children. It is not clear whether respondents feel that the Active Movement resources do not achieve this.

The next theme that emerged was respondents stating the resources were available or easy to find, easily accessible. This availability was either mentioned in terms of within the work place (i.e., available in the centre), local (provided by local organisation), or online (found using web search). This theme contrasts results of question 17 and question 20. Question 20 asked why respondents had not used the Active Movement resources, only six respondents identified availability as their reason for not using the resources. Question 17 asked how those respondents who used the resources viewed their accessibility, only 12 respondents identified the resources as not being easy to access.

A sub-theme with these two main themes were respondents wanting to increase the breadth of their knowledge base. This was demonstrated with respondents looking for new ideas, gaining extra ideas, as back up material, provide a range of resources, more in-depth, part of professional development.