

Institute for Physical Activity and Nutrition, Deakin University: Submission to Parliament of Australia Senate Committee: Inquiry into the Obesity Epidemic in Australia

About the Institute for Physical Activity and Nutrition (IPAN)

IPAN is a world-leading research institute of more than 70 active research staff committed to improving health and quality of life in the population. Our vision is to improve the health of all populations through physical activity and nutrition research excellence.

IPAN's research addresses many of the chronic health conditions impacting Australia's health including obesity, cardiovascular disease, diabetes, and musculoskeletal and mental health conditions. Our research is solutions focused and used in the development of nutrition- and physical activity-related policy as well as new programs.

Summary

There is copious evidence regarding the prevalence, causes and consequences of overweight and obesity. It is time now for coordinated government and community action to implement evidence-based recommendations and strategies to address this health condition.

IPAN strongly supports a comprehensive, coordinated adequately funded approach to addressing the obesity epidemic in Australia. We urge the Senate Committee to consider the evidence based recommendations provided in key international and national documents such as the World Health Organization's (WHO) *Report of the Committee on Ending Childhood Obesity*³², the WHO's *Global action plan on physical activity*⁵⁶, the Australian Institute of Health and Welfare's *A Picture of Overweight and Obesity in Australia*¹, the Obesity Policy Coalition's *Tipping the Scales* report⁷⁰, and the Heart Foundation's *Move More Sit Less Canberra Communique*⁷¹, to inform the development of an Obesity action plan for Australia.

A comprehensive approach to addressing overweight and obesity must include nutrition, physical activity and sedentary behaviour and address environmental factors. Critical to the success of implementation of an Obesity Action Plan will be a long-term funded commitment to appropriate monitoring and surveillance, as well as quality evaluation.

Response to the Terms of Reference

a. The prevalence of overweight and obesity among children in Australia and changes in these rates over time

A number of recent Australian documents¹⁻³ provide data on the prevalence of overweight and obesity among children in Australia and changes in rates over time. The evidence indicates overweight and obesity in children in Australia is a serious problem with significant health and economic consequences.

- In 2014–15, 1 in 5 (20%) children aged 2–4 were overweight or obese—11% were overweight but not obese, and 9% were obese. About 1 in 4 (27%) children and adolescents aged 5–17 were overweight or obese—20% were overweight but not obese, and 7% were obese¹.
- Children and adolescents aged 10–17 in 2014–15 were more likely to be overweight or obese than those 20 years earlier. At age 10–13, 30.8% of children and adolescents born in 2002–2005 were overweight or obese, compared with 23.9% of those born in 1982–1985. At age 14–17, 29.8% of adolescents born in 1998–2001 were overweight or obese, compared with 18.7% of those born in 1978–1981².

- Children aged 2–5 in 2014–15 were twice as likely to be obese than those 20 years earlier².
- Of substantial concern, there is a widening socioeconomic divide, with children living in disadvantage more likely to be overweight or obese than those from less disadvantaged families. These inequalities in obesity emerge and strengthen during childhood suggesting that children living in disadvantage should be a government priority⁴.

b. The causes of the rise in overweight and obesity in Australia

Put simply, overweight and obesity results from an imbalance between energy intake and energy expenditure. Unfortunately, The Lancet Obesity Series II was correct in arguing that “the [obesity] debate is becoming increasingly polarised with false and unhelpful dichotomies”⁵. Obesity is a consequence of inadequate physical activity, too much sitting, and excessive poor dietary intake. All of these elements contribute to energy imbalance which leads to unhealthy weight gain and long-term health consequences. Environmental factors such as the physical environment in which people live, work and play, and social, political and economic factors can also influence energy balance.

Early intervention appears critical given the strong evidence that obese children are more likely to exhibit cardiovascular risk factors, including raised blood pressure and hypertension⁶ and adverse lipid profiles⁷. Overweight toddlers and pre-schoolers are more likely to become overweight or obese children and adults⁸.

Physical Activity and Sedentary Behaviour

The evidence clearly demonstrates the role of both physical inactivity and sedentary behaviour in overweight and obesity.

- Moderate-to-vigorous intensity physical activity (MVPA) is associated with lower levels of adiposity^{9,10}.
- As noted in the systematic review documents underpinning Australia’s guidelines for physical activity and sedentary behaviour for children, and young people^{11, 12}, being physically active and reducing sedentary behaviours assist with prevention of weight gain and reduction in adiposity.
- Our research has shown that children who spend more time being active outdoors are up to 40% less likely to be overweight or obese three years later¹³ compared to children who spend little time outdoors.
- Extensive sedentary behaviour (such as sitting watching TV and computer use) is also a major risk factor for overweight and obesity from a young age¹⁴. This is independent of physical activity levels. For example, our research has shown that Australian children (aged 7-10 years) who watch high amounts of television have a higher body mass index and waist circumference, and higher systolic blood pressure¹⁵. Further research has shown that prolonged TV viewing and sitting time is unfavourably associated with several markers of inflammation and endothelial dysfunction from as young as 8-9 years of age¹⁶.

Motor competence and obesity

One way to improve children’s physical activity is to develop their fundamental movement (or motor) skill (FMS) competence¹⁷⁻²⁰. Children who have full mastery of their FMS have higher levels of physical activity and fitness in adolescence. Indeed, skill competence may prevent the decline in physical activity noted in adolescence²¹⁻²³. FMS is a key component of physical literacy. In 2016, Associate Professor Lisa Barnett (co-leader) and Professor Jo Salmon from IPAN contributed to the development of the definition of physical literacy for the Australian Sports Commission²⁴. Having a physically literate population (of all ages,

backgrounds and abilities) is an important goal for the Committee to consider in tackling the obesity epidemic in Australia.

- 'Motor competence' is a global term used to reflect various terminologies (i.e. motor proficiency, motor performance, fundamental movement/motor skill, motor ability, and motor coordination) to describe goal-directed human movement²⁵.
- In 2008, a conceptual model was presented which described that children who participate in more physical activity develop better motor competence, and that this in turn helps them develop healthy weight trajectories²⁶. Conversely, children with poorer skills are less active and this compounds the chance of unhealthy weight trajectories²⁶. One explanation is that it is harder to propel the body in physical activity when you carry excess mass. In the last decade much research has confirmed this.
- Australian school children leave primary school without the basic motor competence they need to participate in play and sport²⁷⁻²⁹.
- We conducted a systematic review which showed strong evidence that higher BMI in childhood was negatively correlated with motor coordination and total measures of skill. Similarly, other measures of adiposity, including higher waist circumference and percentage body fat, were negatively correlated with motor competence³⁰. As an example, a longitudinal study showed that children's body mass at baseline negatively predicted and explained over a third of the variation in gross motor coordination over time³¹.

Thus the low motor competence of Australian children could conceivably be related to the rise in overweight/obesity. Our systematic review also showed there was no evidence for BMI being negatively associated with object control (ball related skills e.g. throwing) skills. This is good news as it means overweight and obese children can perform these skills without weight being a barrier and thus a focus on these skills might encourage them to participate in physical activities.

Active travel and obesity

Evidence shows that active travel is an important strategy for increasing physical activity. In addition, the reduction of time spent in active travel is a risk factor for obesity. Active travel includes walking, cycling, skateboarding, scootering or rollerblading to get from point A to point B.

- The WHO *Report of the Commission on Ending Childhood Obesity*³² identified reductions in the amount of time children engage in physical activity for play and active transport as a key obesity risk factor.
- To improve active travel, environmental factors need to be addressed. A study by Aarts et al 2012³³ identified traffic safety concerns and presence of footpaths as important environmental factors impacting active transport in children.
- A study by Frank et al 2004³⁴ reported that among adults, there was a 6% increase in the likelihood of obesity for each hour spent in a car, and a 4.8% lower likelihood of obesity with each kilometer walked per day.
- Promoting active travel is an important strategy to increase population levels of physical activity. A number of studies demonstrate that active travel is associated with greater overall physical activity³⁵⁻³⁷.
- Active travel in children is associated with less overweight and obesity³⁸⁻⁴¹.

Dietary intake

Dietary intake plays a critical role in weight management as well as the health consequences of overweight and obesity. High energy dense, nutrient poor foods and drinks can contribute to energy imbalance and weight gain, whilst low energy dense, nutrient rich foods and eating patterns rich in vegetables are associated with a lower risk of weight gain¹. The Australian Dietary Guidelines provide evidence based eating recommendations associated with better health, including better weight outcomes.

- Data from the Australian Bureau of Statistics⁴² shows high prevalence of dietary intakes not meeting Australian Dietary Guidelines from two years of age (especially for vegetables, fruits and discretionary foods).
- Currently in Australia there is no National dietary data collection for children under two years. Our recently published research⁴³ provides Australian evidence comparing diets of children under two years to Australian Dietary Guidelines. This shows high prevalence of intakes not meeting dietary guidelines from as early as 9 and 18 months of age.
- The development of poor dietary habits from early life are a major concern for the future health of the population, not just in relation to prevalence of overweight and obesity, and indicates that early intervention will be critical to address overweight and obesity.

Early intervention

- A number of systematic reviews including one of our own⁴⁴⁻⁴⁸ provide strong evidence that the first thousand days of life (i.e. from conception to age two years) is a critical period influencing the likelihood of obesity in infancy, childhood and later in life.
- Nutrition factors in early life have been shown to influence obesity risk later in life, with breastfeeding providing protection^{44, 49}, while early introduction of solids before 4 months^{46, 47} and inappropriate formula feeding practices (e.g. over concentration, feeding set amounts)⁴⁷ were identified as risk factors.
- Rapid weight gain in infants is associated with increased obesity risk. Our recent systematic review⁴⁸ found that infants between birth and two years of age, experiencing rapid weight gain (defined as crossing centiles on a growth chart) had nearly four times greater odds of being overweight/obese later in life. A study by Andrea et al 2017⁵⁰ reported the associations between rapid weight gain and later overweight and obesity are strongest for racial/ethnic minority and low socioeconomic status children, with another study by Cameron et al 2015⁵¹ indicating a strong socioeconomic gradient existing for the majority of the early life predictors of obesity.
- A review of 36 studies⁵² has revealed six key obesogenic environments influencing obesity related dietary behaviours in young children, these include schools, retailers, mass media (television and internet) home and promotional campaigns.

c. The short and long-term harm to health associated with obesity, particularly in children in Australia

Obesity in children is associated with a number of serious health consequences. The AIHW report, *A Picture of Overweight and Obesity in Australia*¹ cites references indicating that:

- Obese children are at a higher risk of breathing difficulties, fractures, hypertension, insulin resistance, and early markers of cardiovascular disease.
- Overweight and obese children are also more likely to become obese adults, and to develop chronic conditions at younger ages, including cardiovascular disease and type 2 diabetes.

Obese children are more likely to exhibit cardiovascular risk factors, including raised blood pressure and hypertension⁶ and adverse lipid profiles⁷.

d. The short and long-term economic burden of obesity, particularly related to obesity in children in Australia

There is no doubt that overweight and obesity significantly impacts our economy. This is both through direct costs to the healthcare system, as well as indirect costs such as absenteeism and loss of productivity.

The AIHW report, *A Picture of Overweight and Obesity in Australia*¹ provides some insight into the economic burden of obesity in general, citing the following:

- In 2014–15, more than 124,600 procedures related to weight-loss surgery were billed to Medicare—in public and private hospitals, and in non-hospital settings. The total costs for these Medicare-billed procedures were about \$62.8 million, with about \$25.7 million in benefits paid by Medicare, and about \$37.1 million paid in out-of-pocket costs by patients and/or health insurers.
- PwC Australia estimated that obesity cost the Australian economy \$8.6 billion in 2011–12 (in 2014–15 dollars). This included an estimated \$3.8 billion in direct costs and \$4.8 billion in indirect costs, but did not account for further costs from reduced wellbeing and forgone earnings. The report estimated that, if no further action is taken to slow the rise in obesity, there will be \$87.7 billion in additional costs due to obesity over a 10-year period (2015–16 to 2024–25).

A recent international systematic review by Tremmel et al 2017⁵³ reported a substantial economic burden of obesity in both developed and developing countries and that obesity is responsible for a large fraction of costs, not only to the health care system but also to society at large.

e. The effectiveness of existing policies and programs introduced by Australian governments to improve diets and prevent childhood obesity

Our recent research by Lawrence et al 2018⁵⁴ monitoring and evaluating the existing Health Star Rating (HSR) program indicates the current Health Star Rating system is undermining the Australian Dietary Guidelines (ADG). The study indicated that 57% of new discretionary foods entering the marketplace are displaying 2.5 or more stars. As such the HSR system is undermining the ADG recommendations through facilitating the marketing of discretionary foods. Adjusting the HSR's algorithm might correct certain technical flaws. However, in our view supporting the ADGs requires reform of the HSR's design to demarcate the food source (Five food group versus discretionary food) of a nutrient.

f. Evidence-based measures and interventions to prevent and reverse childhood obesity, including experiences from overseas jurisdictions

Numerous national and international reports exist that have reviewed the evidence for preventing and reversing obesity generally including in childhood, and that provide evidence based recommendations to be implemented. These include:

- The WHO *Report of the Commission on Ending Childhood Obesity*³² provides a number of recommendations based on evidence for ending childhood obesity.
- The Cochrane Library provides a useful summary of the effectiveness of various interventions for preventing obesity in children⁵⁵.
- The WHO *Global Action Plan on Physical Activity*⁵⁶ comprehensively outlines the whole-of-system approach required to create a society that intrinsically values and prioritizes policy investments in physical activity as

a regular part of everyday life. The plan outlines four key objectives and 20 evidence based policy actions for increasing physical activity in children, adolescents and adults.

- Pietrobelli et al 2017⁵⁷ propose ten good practices to help prevent obesity in the first 1000 days of life based on published evidence.

From our own team, a number of interventions have demonstrated success in impacting overweight and obesity or important obesity risk factors. These include:

- The Melbourne InFANT program^{58, 59} a lifestyle program delivered to parents of infants over the first 18 months of life demonstrated the following outcomes:
Compared to those not involved in the program, the mothers:
 - were less likely to employ undesirable feeding practices (e.g. use of pressure in child feeding, use of food as rewards)
 - reported higher levels of self-efficacy to limit their child's consumption of unhealthy foodsCompared to those not involved in the program, the children:
 - watched less television
 - ate fewer non-core sweet snacks
- The Transform Us! Program, a two-and-a-half year school- and family-based intervention aimed at promoting physical activity and reducing sitting time among primary school children was highly successful⁶⁰⁻⁶². Key outcomes included:
 - Children in the sedentary behaviour intervention group spending 28 minutes less per average day in sedentary time compared with the usual school curriculum.
 - Children in the physical activity intervention group significantly increased their physical activity at recess and lunchtime by 33 minutes per week.
 - Halfway through the program, children in the combined physical activity and sedentary behaviour intervention group spent more time in light-intensity physical activity on weekend days (25 mins/day) and at the end of the program they spent 23 minutes less time sedentary compared to at the start of the program.
 - There were also substantial benefits to children's health including significantly lower body mass index and lower waist circumference (2cm difference between children in the program compared to those in the control group).

The program, with support from the National Health and Medical Research Council is currently being scaled up for statewide rollout to all primary schools in Victoria.

- The REVAMP project⁶³, a natural experiment investigating the impact of park refurbishment on physical activity levels in parks and visits to parks, provides crucial evidence that the design and installation of a new play-space has the potential to positively influence park visitation and park-based physical activity among children and adults.

A couple of systematic reviews by members of our team also provide useful insights:

- A review of the literature by Laws et al 2014⁶⁴ on the impact of interventions to prevent obesity or improve obesity related behaviours in children (0-5 years) from socioeconomically disadvantaged and/or indigenous families, reported that the findings of obesity prevention interventions amongst socioeconomically disadvantaged families are promising, when commenced in early infancy, although longer term follow up is required to assess the impact on healthy weight gain. The review also reported that interventions amongst pre-schoolers including racial and ethnic minority groups are more effective when they have a strong

component of parental engagement, use evidence based behaviour change techniques, focus on building skills not just knowledge acquisition, provide rewards and links to social networking opportunities and community resources. Whilst most of the studies included in the review were of low quality and it was identified that more studies of better quality are needed, the review provides some important insights with these key population groups.

- A review of the literature by Downing et al 2016⁶⁵ of interventions to reduce sedentary behaviour in 0-5 year olds concluded that interventions to decrease screen time and sedentary time in children aged birth through 5 years have a relatively large, statistically significant overall effect. This supports the implementation of interventions in early childhood to reduce sedentary behaviours, and suggests that this appears to be an ideal age to intervene.

There is also evidence indicating that intervening in preschools has motor competence effects three years later⁶⁶, particularly for girls - who are at high risk of physical inactivity and poor motor competence. As physical inactivity is a key risk factor for obesity, a focus on movement skills in early childhood settings should be considered as a strategy for addressing childhood obesity.

g. The role of the food industry in contributing to poor diets and childhood obesity in Australia

Access to healthy, nutritious food and beverages is critical for population health. The food industry has an important role to play in providing and promoting healthier food options. Whilst improvements have been made in recent years, there is still a lot of work to be done by food industry to reformulate or produce food and beverage products with a better nutrition profile. There is also still much to be done in the way that foods and beverages are marketed to encourage consumption of healthier options over less healthy options and to reduce consumer confusion over whether a product is a healthy choice or not.

- A recent study conducted in 2015⁶⁷ investigating new foods introduced into the Australian market, showed the majority of the 4143 new products launched were classified in the least healthy categories of three separate schemes [Healthy Choices Framework Victoria (red category), Australian Dietary Guidelines (discretionary foods) and NOVA Food Classification System (ultra-processed)]. Fruits and vegetables represented just 3% of new products. Interestingly, a greater proportion of new products launched by companies that publicly committed to improve the nutritional quality of their products were unhealthy, and a lower proportion were healthy, compared with new products launched by companies that did not so commit. Greater monitoring of industry progress in improving the healthfulness of the food supply may be warranted, with public accountability if the necessary changes are not seen.
- The WHO provides a number of reports^{32, 68, 69} which provide recommendations related to the role of food industry in addressing childhood obesity.

h. Other related matters

- We recommend the development of a whole-of-government evidence-based Obesity action plan for Australia that is adequately resourced and evaluated. Simple, but costly, mass media campaigns have achieved little but have been the major focus of previous government obesity initiatives. We urge the Committee to consider a more sophisticated evidence-based approach following recommendations provided in the WHO's *Report of the Committee on Ending Childhood Obesity*³², the WHO's *Global Action Plan on Physical Activity*⁵⁶, the Australian Institute of Health and Welfare's *A Picture of Overweight and Obesity in Australia*¹, the *Tipping the Scales* report⁷⁰, and the Heart Foundation's *Move More Sit Less Canberra Communique*⁷¹.

- We recommend implementation of an ongoing national system for nutrition, physical activity, sedentary behaviour and population weight monitoring and surveillance. This is vital to determine what needs to change and assess impact of interventions. The 2011-2013 Australian Health Survey provided much needed, and long overdue evidence on the current dietary and physical activity habits of the Australian population. Data of this nature is necessary for development and evaluation of a range of food and nutrition and physical activity related guidelines and policies. It would be used by a wide range of health agencies in Australia to develop and implement evidence-based policies and programs to improve population health, inclusive of addressing overweight and obesity.
- We also believe there is a need for comprehensive national policies around food and nutrition, and physical activity and sedentary behaviour in order to ensure coordination of action across government at all levels and other sectors. In the nutrition area, the federal government previously commissioned and conducted extensive scoping work around the development of a National Nutrition Policy⁷² however, this has never been implemented. We recommend this be revisited. In the physical activity area, we are aware of the pending release of the National Sports Plan, however, there is potential this may not adequately address physical activity and sedentary behaviour. We recommend development of a National Physical Activity Plan (please see the Heart Foundation's *Move More Sit Less Canberra Communique*⁷¹ which would include sport, but would have a far greater impact on obesity levels. Focusing primarily on sport participation will not solve the obesity epidemic in Australia, nor will it reach those who are most at risk.
- Finally, quality evaluation of government initiated programs and interventions needs to be undertaken and adequately resourced so effectiveness can be assessed and further investment can be appropriately allocated. Quality evaluation will also enable the Australian government to demonstrate progress towards addressing the obesity epidemic in Australia.

REFERENCES

1. Australian Institute of Health and Welfare 2017. A Picture of Overweight and Obesity in Australia 2017. Cat. no.PHE 216. Canberra: AIHW.
2. Australian Institute of Health and Welfare 2017. Overweight and Obesity in Australia: a birth cohort analysis. Cat. no. PHE 215. Canberra: AIHW.
3. <https://www.aihw.gov.au/reports/overweight-obesity/interactive-insight-into-overweight-and-obesity/contents/how-many-people-are-overweight-or-obese>
4. Jansen PA, Mensah FK, Nicholson FK, Wake M. (2013) Family and Neighbourhood Socioeconomic Inequalities in Childhood Trajectories of BMI and Overweight: Longitudinal Study of Australian Children. PLOS ONE 8(7).
5. Kleinert S, Horton R. (2015) Rethinking and reframing obesity. The Lancet Vol 385; 2326-2328.
6. Bell, LM, Byrne, S, Thompson, A, Ratnam, N, Blair, E, Bulsara, M, Jones, TW & Davis, EA 2007, 'Increasing body mass index z-score is continuously associated with complications of overweight in children, even in the healthy weight range', Journal of Clinical Endocrinology and Metabolism, vol. 92, no. 2, pp. 517-22.
7. Freedman, DS, Kahn, HS, Mei, Z, Grummer-Strawn, LM, Dietz, WH, Srinivasan, SR & Berenson, GS 2007, 'Relation of body mass index and waist-to-height ratio to cardiovascular disease risk factors in children and adolescents: the Bogalusa Heart Study', The American Journal of Clinical Nutrition, vol. 86, no. 1, pp. 33-40.
8. Wheaton N, Millar L, Allender S, Nichols M: The stability of weight status through the early to middle childhood years in Australia: a longitudinal study. BMJ Open 2015, 5(4):e006963.
9. Janssen I, Leblanc AG. Systematic review of the health benefits of physical activity and fitness in school-aged children and youth [Int J Behav Nutr Phys Act.](#) 2010 May 11;7:40. doi: 10.1186/1479-5868-7-40.
10. Poitras VJ, Gray CE, Borghese MM, Carson V, Chaput JP, Janssen I, Katzmarzyk PT, Pate RR, Connor Gorber S, Kho ME, Sampson M, Tremblay MS. Systematic review of the relationships between objectively measured physical activity and health indicators in school-aged children and youth. [Appl Physiol Nutr Metab.](#) 2016 Jun;41(6 Suppl 3):S197-239. doi: 10.1139/apnm-2015-0663.
11. Okely AD, Salmon J, Vella S, et al. A Systematic Review to update the Australian Physical Activity Guidelines for Children and Young People. Report prepared for the Australian Government Department of Health, Canberra, 2013, pp.1-56; Online ISBN: 978-1-74186-068-9.
12. Okely AD, Salmon J, Vella S, et al. A Systematic Review to update the Australian Sedentary Behaviour Guidelines for Children and Young People. Report prepared for the Australian Government Department of Health, Canberra, 2013, pp.1-56; Online ISBN: 978-1-74186-068-9.
13. Cleland V, Crawford D, Baur L, Hume C, Timperio A, Salmon J. (2008) A prospective examination of children's time spent outdoors, objectively measured physical activity and overweight. International Journal of Obesity 32: 1685–1693.
14. Salmon J, Tremblay M, Marshall S, Hume C. (2011) Health risks, correlates and interventions to reduce sedentary behavior in young people. American Journal of Preventive Medicine 41:197–206.
15. Robinson S, Daly RM, Ridgers ND, Salmon J. (2015). Screen-based behaviors of children and cardiovascular risk factors. Journal of Pediatrics. 167(6): 1239-1245.
16. Gabel L, Ridgers ND, Della Gatta PA, Arundell L, Cerin E, Robinson S, Daly RM, Dunstan DW, Salmon J (2016). Associations of sedentary time patterns and TV viewing time with inflammatory and endothelial function biomarkers in children. Pediatric Obesity. 11(3): 194-201.
17. Holfelder, B. and N. Schott, Relationship of fundamental movement skills and physical activity in children and adolescents: A systematic review. Psychology of Sport and Exercise, 2014. 15(4): p. 382-391. 12.
18. Lubans, D.R., et al., Fundamental movement skills in children and adolescents: Review of Associated Health Benefits Sports Medicine, 2010. 40(12): p. 1019-1035.
19. Robinson, L.E., et al., Motor Competence and its Effect on Positive Developmental Trajectories of Health. Sports Medicine, 2015. 45(9): p. 1273-1284. 14.
20. Logan, S.W., et al., The relationship between motor competence and physical activity engagement during childhood: A systematic review. Kinesiology Review, 2015. 4: p. 416-426.
21. Barnett, L., et al., Perceived sports competence mediates the relationship between childhood motor skill proficiency and adolescent physical activity and fitness: a longitudinal assessment. International Journal of Behavioral Nutrition and Physical Activity, 2008. 5(1): p. 40.
22. Barnett, L.M., et al., Childhood motor skill proficiency as a predictor of adolescent physical activity. Journal of Adolescent Health, 2009. 44: p. 252-259.
23. Lopes, V.P., et al., Motor coordination as predictor of physical activity in childhood. Scandinavian Journal of Medicine & Science in Sports, 2011. 21(5): p. 663-669.
24. https://www.ausport.gov.au/participating/physical_literacy

25. Robinson LE, Stodden DF, Barnett LM, Lopes VP, Logan SW, Rodrigues LP, et al. Motor Competence and its Effect on Positive Developmental Trajectories of Health. *Sports medicine (Auckland, NZ)*. 2015; 45: 1273-84.
26. Stodden DF, Goodway JD, Langendorfer SJ, Robertson MA, Rudisill ME, Garcia C, et al. A developmental perspective on the role of motor skill competence in physical activity: An emergent relationship. *Quest*. 2008; 60: 290-306.5).
27. Barnett LM, Hardy LL, Lubans DR, Cliff DP, Okely AD, Hills AP, et al. Australian children lack the basic movement skills to be active and healthy. *Health Promotion Journal of Australia*. 2013; 24: 82-84.
28. Hardy LL, Barnett LM, Espinel P, Okely AD. Thirteen-year trends in child and adolescent fundamental movement skills: 1997–2010. *Medicine & Science in Sports & Exercise*. 2013; 45: 1965-70. 10.249/MSS.0b013e318295a9fc.
29. Hardy LL, Mihrshahi S, Drayton BA, Bauman A. NSW Schools Physical Activity and Nutrition Survey (SPANS) 2015: Full Report. NSW Department of Health: Sydney 2016.
30. Barnett LM, Lai SK, Veldman SLC, Hardy LL, Cliff DP, Morgan PJ, et al. Correlates of Gross Motor Competence in Children and Adolescents: A Systematic Review and Meta-Analysis. *Sports Medicine*. 2016; 46: 1663-88).
31. D'Hondt E, Deforche B, Gentier I, De Bourdeaudhuij I, Vaeyens R, Philippaerts R, et al. A longitudinal analysis of gross motor coordination in overweight and obese children versus normal-weight peers. *Int J Obes (Lond)*. 2013; 37: 61-7.
32. World Health Organization: Report of the commission on ending childhood obesity. In. Geneva: World Health Organization; 2016.
33. Aarts MJ, de Vries SI, van Oers HAM, Schuit AJ: Outdoor play among children in relation to neighborhood characteristics: a cross-sectional neighborhood observation study. *International Journal of Behavioral Nutrition and Physical Activity* 2012; 9:98.
34. Frank LD, Andresen, MA, Schmid, TL. Obesity Relationships with Community Design, Physical Activity, and Time Spent in Cars. 2004. *Am J Prev Med* 2004;27(2):87–96.
35. Sahlqvist, S., Song, Y., & Ogilvie, D. (2012). Is active travel associated with greater physical activity? The contribution of commuting and non-commuting active travel to total physical activity in adults. *Preventive Medicine*, 55(3), 206-211. doi: <https://doi.org/10.1016/j.ypmed.2012.06.028>
36. Sahlqvist, S., Goodman, A., Cooper, A. R., & Ogilvie, D. (2013). Change in active travel and changes in recreational and total physical activity in adults: longitudinal findings from the iConnect study. *International Journal of Behavioral Nutrition and Physical Activity*, 10(1), 28. doi: 10.1186/1479-5868-10-28.
37. Sahlqvist, S., Goodman, A., Simmons, R. K., Khaw, K.-T., Cavill, N., Foster, C., . . . Ogilvie, D. (2013). The association of cycling with all-cause, cardiovascular and cancer mortality: findings from the population-based EPIC-Norfolk cohort. *BMJ Open*, 3(11). doi: 10.1136/bmjopen-2013-003797.
38. Lubans, D. R., Boreham, C. A., Kelly, P., & Foster, C. E. (2011). The relationship between active travel to school and health-related fitness in children and adolescents: a systematic review. *International Journal of Behavioral Nutrition and Physical Activity*, 8(1), 5. doi: 10.1186/1479-5868-8-5.
39. Bere, E., Oenema, A., Prins, R. G., Seiler, S., & Brug, J. (2011). Longitudinal associations between cycling to school and weight status. *International Journal of Pediatric Obesity*, 6(3-4), 182-187. doi: doi:10.3109/17477166.2011.583656.
40. Østergaard, L., Grøntved, A., Børrestad, L. A. B., Froberg, K., Gravesen, M., & Andersen, L. B. (2012). Cycling to School Is Associated With Lower BMI and Lower Odds of Being Overweight or Obese in a Large Population-Based Study of Danish Adolescents. *Journal of Physical Activity and Health*, 9(5), 617-625. doi: 10.1123/jpah.9.5.617.
41. Drake, K. M., Beach, M. L., Longacre, M. R., MacKenzie, T., Titus, L. J., Rundle, A. G., & Dalton, M. A. (2012). Influence of Sports, Physical Education, and Active Commuting to School on Adolescent Weight Status. *Pediatrics*, 130(2), e296-e304. doi: 10.1542/peds.2011-2898.
42. <http://www.abs.gov.au/ausstats/abs@.nsf/Lookup/4364.0.55.007main+features22011-12>
43. Spence AC, Campbell KJ, Lioret S, McNaughton SA. Early Childhood Vegetable, Fruit, and Discretionary Food Intakes Do Not Meet Dietary Guidelines, but Do Show Socioeconomic Differences and Tracking over Time. *J Acad Nutr Diet*. 2018 Feb 23. pii: S2212-2672(17)31965-2. doi: 10.1016/j.jand.2017.12.009.
44. Monasta L, Batty GD, Cattaneo A, Lutje V, Ronfani L, Van Lenthe FJ, Brug J: Early-life determinants of overweight and obesity: A review of systematic reviews. *Obesity Reviews* 2010, 11(10):695-708.
45. Patro-Gołąb B, Zalewski BM, Kołodziej M, Kouwenhoven S, Poston L, Godfrey KM, Koletzko B, van Goudoever JB, Szajewska H: Nutritional interventions or exposures in infants and children aged up to 3 years and their effects on subsequent risk of overweight, obesity and body fat: a systematic review of systematic reviews. *Obesity Reviews* 2016, 17(12):1245-1257.
46. Wang J, Wu Y, Xiong G, Chao T, Jin Q, Liu R, Hao L, Wei S, Yang N, Yang X: Introduction of complementary feeding before 4 months of age increases the risk of childhood overweight or obesity: A meta-analysis of prospective cohort studies. *Nutrition Research* 2016, 36(8):759-770.
47. Woo Baidal JA, Locks LM, Cheng ER, Blake-Lamb TL, Perkins ME, Taveras EM: Risk Factors for Childhood Obesity in the First 1,000 Days: A Systematic Review. *American Journal of Preventive Medicine* 2016, 50(6):761-779.
48. Zheng M, Lamb KE, Grimes C, Laws R, Bolton K, Ong KK, Campbell K: Rapid weight gain during infancy and subsequent adiposity: a systematic review and meta-analysis of evidence. *Obesity Reviews* 2018, 19(3):321-332.
49. Weng SF, Redsell SA, Swift JA, Yang M, Glazebrook CP: Systematic review and meta-analyses of risk factors for childhood overweight identifiable during infancy. *Archives of disease in childhood* 2012, 97(12):1019-1026.

50. Andrea SB, Hooker ER, Messer LC, Tandy T, Boone-Heinonen J: Does the association between early life growth and later obesity differ by race/ethnicity or socioeconomic status? A systematic review. *Annals of Epidemiology* 2017, 27(9):583-592.e585.
51. Cameron AJ, Spence AC, Laws R, Hesketh KD, Lioret S, Campbell KJ: A Review of the Relationship Between Socioeconomic Position and the Early-Life Predictors of Obesity. *Current obesity reports* 2015, 4(3):350-362.
52. Sonntag D, Schneider S, Mdege N, Ali S, Schmidt B: Beyond food promotion: A systematic review on the influence of the food industry on obesity-related dietary behaviour among children. *Nutrients* 2015, 7(10):8565-8576.
53. Tremmel M, Gerdtham UG, Nilsson PM, Saha S. Economic Burden of Obesity: A Systematic Literature Review. *Int J Environ Res Public Health*. 2017 Apr; 4(4): 435. doi: 10.3390/ijerph14040435.
54. Lawrence MA, Dickie S, Woods JL. Do Nutrient-Based Front-of-Pack Labelling Schemes Support or undermine Food-Based Dietary Guideline Recommendations? Lessons from the Australian Health Star Rating System. *Nutrients* 2018, 10, 32; doi:10.3390/nu10010032.
55. [http://www.cochranelibrary.com/app/content/special-collections/article/?doi=10.1002/\(ISSN\)14651858\(CAT\)na\(VI\)SC000025](http://www.cochranelibrary.com/app/content/special-collections/article/?doi=10.1002/(ISSN)14651858(CAT)na(VI)SC000025)
56. Global Action Plan on Physical Activity 2018–2030: more active people for a healthier world. Geneva: World Health Organization; 2018. Licence: CC BY-NC-SA 3.0 IGO.
57. Pietrobelli A, Agosti M; MeNu Group. Nutrition in the First 1000 Days: Ten Practices to Minimize Obesity Emerging from Published Science. *Int J Environ Res Public Health*. 2017 Dec 1;14(12). pii: E1491. doi: 10.3390/ijerph14121491.
58. Campbell KJ, Lioret S, McNaughton SA, Crawford DA, Salmon J, Ball K, McCallum Z, Gerner BE, Spence AC, Cameron AJ, Hnatiuk JA, Ukoumunne OC, Gold L, Abbott G, Hesketh KD. 2013, A parent-focused intervention to reduce infant obesity risk behaviors: a randomized trial, *Pediatrics*, 2013;131(4):652–60., doi: 10.1542/peds.2012-2576.
59. Hesketh K, Salmon J, Crawford D, Ball K, Abbott G, Campbell K. Impacts of the Melbourne InFANT Program help explain the mechanisms of behaviour change observed in toddlers’ television viewing. *Journal of Science and medicine in sport* December 2014 Volume 18, Supplement 1, Page e123.
60. Salmon J, Arundell L, Hume C, Brown H, Hesketh K, Dunstan DW, Daly RM, Pearson N, Cerin E, Moodie M, Sheppard L, Ball K, Robinson S, Chin A Paw M, Crawford D. (2011) A cluster-randomized controlled trial to reduce sedentary behavior and promote physical activity and health of 8-9 year olds: The Transform-Us! Study. *BMC Public Health* 11: 759.
61. Carson V, Salmon J, Arundell L, Ridgers ND, Cerin E, Brown H, Hesketh KD, Ball K, Chinapaw M, Yildirim M, Daly RM, Dunstan DW, Crawford D. (2013) Examination of mid-intervention mediating effects on objectively assessed sedentary time among children in the Transform-Us! cluster-randomized controlled trial. *Int J Behav. Nutr. Phys. Act.* 10(1): 62.
62. Yildirim M, Arundell L, Cerin E, Carson V, Brown H, Crawford D, Hesketh KD, Ridgers ND, te Velde SJ, Chinapaw MJM, Salmon J. (2014) What helps children to move more at school recess and lunchtime? Mid-intervention results from Transform-Us! cluster-randomized controlled trial. *Brit J Sport Med* 48: 271-277).
63. Veitch J, Salmon J, Crawford D, Abbott G, Giles-Corti B, Carver A, Timperio A. (2018). The REVAMP natural experiment study: the impact of a play-scape installation on park visitation and park-based physical activity. *International Journal of Behavioral Nutrition and Physical Activity*. 15: 10.)
64. Laws R, Campbell K, van der Pliigt P, Russell G, Ball K, Lynch J, Crawford D, Taylor R, Askew D, Denney-Wilson E. 2014. The impact of interventions to prevent obesity or improve obesity related behaviours in children (0-5 years) from socioeconomically disadvantaged and/or indigenous families: a systematic review, *BMC public health*, vol. 14, no. 1, Article 779, pp. 1-18, doi: 10.1186/1471-2458-14-779.
65. Downing, Katherine, Hnatiuk, Jill, Hinkley, Trina, Salmon, Jo and Hesketh, Kylie 2016, Interventions to reduce sedentary behaviour in 0-5-year-olds: A systematic review and meta-analysis of randomised controlled trials, *British journal of sports medicine*, pp. 1-10, doi: 10.1136/bjsports-2016-096634.
66. Zask A, Barnett LM, Rose L, Brooks LO, Molyneux M, Hughes D, et al. Three year follow-up of an early childhood intervention: is movement skill sustained? *International Journal of Behavioral Nutrition and Physical Activity*. 2012; 9: 127.
67. Spiteri SA, Olstad DL, Woods JL. Nutritional quality of new food products released into the Australian retail food market in 2015 – is the food industry part of the solution? *BMC Public Health* (2018) 18:222. DOI 10.1186/s12889-018-5127-0.
68. Set of Recommendations on the Marketing of Foods and Non-alcoholic Beverages to Children. Geneva: World Health Organization, 2010.
69. Tackling Food Marketing to Children in a Digital World: Trans-disciplinary Perspectives. Geneva: World Health Organization, 2016.
70. Tipping the Scales. Australian obesity prevention consensus. 2017 Obesity Policy Coalition and The Global Obesity Centre, Deakin University.
71. Move More, Sit Less Canberra Communique. 2015 (updated 2016). National Heart Foundation of Australia.
72. Lee A, Baker P, Stanton R, Friel S, O’Dea K, Weightman A. Scoping Study to Inform the Development of the new National Nutrition Policy, 2013, QUT, Australian Department of Health and Ageing (RFT 028/1213). Released under FOI, March 2016.