

Healthy Lifestyle Behaviours Are Associated With Children's Psychological Health: a Cross-Sectional Analysis of Data From the New South Wales Child Population Health Survey 2013-2014

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Abstract

Background Despite numerous studies showing that diet and exercise influence mental health in children, there is limited data available from representative populations of children and adolescents on the relationship between regular healthy lifestyle behaviour and psychological health.

Methods Data were obtained from the New South Wales Child Population Health Survey, 2013–2014. Parents were asked about diet, physical activity and screen time behaviours and completed the Strengths and Difficulties Questionnaire (SDQ) for one child aged 5-15. Higher scores on the SDQ indicate poorer psychological health and risk for mental health problems. Multivariable linear and logistic regression models examined the relationships between dietary consumption, physical activity, screen time and SDQ scores, adjusting for potential confounding.

Results Proportionally more children than adolescents met the guidelines for appropriate diet, physical activity and screen time behaviours. Meeting screen time recommendations was most strongly associated with a lower SDQ total difficulties score (5-10yrs: -1.56 (-2.68, -0.44); 11-15yrs: -2.12 (-3.11, -1.12)). Children and adolescents who met screen time recommendations were also significantly less likely to have any score in the at-risk range. In addition, children and adolescents meeting vegetable intake guidelines had a significantly lower total difficulties score (5-10yrs: -1.54 (-3.03,-0.05); 11-15yrs: -1.19 (-3.60,-0.39)), as did adolescents meeting discretionary food guidelines (-1.16 (-2.14,-0.18)) and children consuming the recommended fruit intake (-1.26 (-2.42,-0.10)).

Conclusions Since adopting regular healthy lifestyle behaviours is associated with better psychological health among children and adolescents, it is imperative that appropriate and effective interventions are implemented to increase these healthy lifestyle behaviours among young Australians.

Background

Unhealthy diets, inadequate amounts of physical activity and increased sedentary behaviour in children contribute to the development of obesity and other cardiovascular risk factors (1). International reviews have found that healthy eating and physical activity in children and adolescents are also associated with better mental health (2-5). Investigations into unhealthy lifestyle behaviours have shown that they contribute to poorer health related quality of life and have a prolonged negative influence on psychological health (2, 6-8). Increased electronic screen time is an issue of growing concern across all developed countries (9, 10), due to evidence of its contribution to increased sedentary behaviour and a host of other undesirable outcomes, including poorer quality of life and behavioural and psychological difficulties (11-14).

There are concerns about the prevalence of mental health problems among Australia's young people, with a large-scale study identifying mild to severe mental disorders in 14% of 4-17 year olds (15). Among younger Australian children, higher diet quality has been associated with better mental health (16), whilst greater physical activity has been linked to fewer depressive symptoms in adolescents.(17). High levels

of discretionary food intake (18, 19) and reduced consumption of fresh fruit and leafy green vegetables (20) have both been linked with adverse adolescent mental health outcomes. The high prevalence of some unhealthy lifestyle behaviours including inappropriate screen time, excess discretionary food intake and low vegetable consumption, indicate that many Australian children may be at risk of experiencing sub-optimal mental health (10, 21, 22). Differences in lifestyle behaviours between children and adolescents supports the need to examine mental health outcomes in these age groups separately (21).

Childhood and adolescence is likely to be a critical time for establishing good mental health but there is still much to be learned about factors that may have a positive impact on psychological health in childhood (23, 24). The evidence for the relationship between children's health behaviours and mental health remains weak, so more research is needed (5). While some studies have pointed to the value of an overall healthy lifestyle (7), there is currently an inadequate understanding of the relative importance of the different behaviours that make up a healthy lifestyle, and how each contributes to children's psychological health. Additionally, research has frequently been conducted among select samples, and often without adequate control for confounding factors, (4) so more analysis of population-based data is needed. The aim of this analysis was to examine the association between key healthy lifestyle behaviours—diet, physical activity and recreational screen time—and risk for mental health problems in a representative population of children aged 5 – 15 living in New South Wales, Australia.

Methods

Data source

Data were obtained from the New South Wales (NSW) Child Population Health Survey (CPHS), 2013 – 2014 (25). The CPHS is a component of the NSW Population Health Survey (PHS), an ongoing survey of health and health related behaviour among people living in NSW, Australia's most populous state, comprising approximately one third of the Australian population. The NSW Ministry of Health conducts the survey using computer-assisted telephone interviewing and randomly selected landline and mobile phone numbers. The data are weighted in order to be representative of the NSW population and to account for the probability of selection.

The CPHS is completed by a parent on behalf of one child or adolescent in their care, aged between 0 and 15, with the Strengths and Difficulties Questionnaire (SDQ) component completed by parents of children aged 4-15. Survey participants provide verbal informed consent and the survey has been approved by the NSW Population and Health Services Research Ethics Committee. Further information on the survey and methods are available from the NSW Ministry of Health Child Population Survey website (25). Our study was restricted to children aged 5-15 years since parents were only asked about physical activity for children 5-15 years.

Exposure measures

Diet: For dietary measures, parents were asked to estimate the number of serves of various types of foods and beverages their child usually consumed per day. A serve of fruit was defined as one medium or two small pieces of fruit, or one cup of diced pieces, and a serve of vegetables was defined as half a cup of cooked or one cup of salad vegetables. Intake of discretionary foods (26) was estimated based on questions about the number of times in a day/week/month children ate the particular foods. Discretionary foods included processed meat, salty snacks, fried potato products, sugary baked goods, fast food, cordial or other sugar-sweetened beverages, and confectionary (26). Appropriate discretionary food consumption was defined as consuming these foods less than three times per week, following Boylan et al. (21). Dietary indicators for fruit and vegetable consumption were based on meeting age-appropriate Australian Dietary Guidelines (Table S1) (27), as survey answers were provided in whole numbers, however, half serves in the recommendations were rounded up to whole serves. This only applied to girls and boys aged 5-8 for fruit and vegetable consumption and boys aged 12-15 for vegetable consumption (see Supplementary Table S1).

Activity: For activity measures, parents were asked to estimate the amount of time their child spent doing physical activity during school hours, outside of school hours and on the weekend, from which total daily average estimates for time spent in physical activity were calculated. Similarly, parents estimated the amount of time their child engaged in screen time activities at home (TV, videos/DVDs, computer games) during the school week and on weekends and total daily average estimates for screen time were calculated. Physical activity and screen time indicators were based on meeting Australia's Physical Activity and Sedentary Behaviour Guidelines for children and adolescents (see Table S1)(28, 29).

Outcome measures

The outcome measures were based on the SDQ which is part of the CPHS questionnaire and completed by all consenting parents caring for a child aged 4-15. The SDQ is a behavioural screening tool for assessing child and adolescent mental health (30) and has been used successfully in populations of Australian children (16, 31). A higher total score relates to a higher level of psychological distress (maximum score of 40) and is predictive of diagnosed mental health problems (30). The SDQ comprises 25 attributes on five scales: 1) emotional symptoms, 2) conduct problems, 3) hyperactivity or inattention, 4) peer relationship problems, and 5) prosocial behaviour, and a total difficulties score obtained by adding scores from the first four scales. A score of 5–10 for emotional symptoms, 7-10 for hyperactivity/inattention, 4–10 for conduct or peer relationship problems, and 0–4 for prosocial behaviour indicates a child is at risk of experiencing problems in that area.

Confounders

Potential confounders included in the analysis were age, sex, body mass index (BMI), mother's highest education qualification (indicator of socioeconomic status), family structure (single parent family) and remoteness of residence. Residential postcode was used to determine remoteness through the Accessibility/Remoteness Index of Australia (ARIA) (32).

Statistical methods

Population level mean and median fruit, vegetable and discretionary food intake, along with hours per day of screen time and physical activity are reported in Table 2.

Multivariable logistic regression models were used to test whether meeting recommendations for each of these lifestyle behaviours was associated with having a score in the at-risk range in any of the five SDQ sub-scales. Logistic regression was also used to examine the association between each diet or activity behaviour and having an at-risk score in each sub-scale individually. Adjustments for demographic confounders were included in each model. A multivariable linear regression model was used to test for an association between the diet and activity behaviours and the total difficulties score. The model included all five diet and activity recommendations, to control for the effect of each recommendation on the other, as well as demographic confounders. Regression models for problems in individual SDQ domains were not analysed due to low cell numbers. Survey weights were included in all models, with models run using the *Survey* Package in R (33). Children/adolescents missing data for any variable included in a model were excluded from that model.

As the distribution of the total difficulties score was right-skewed, a sensitivity analysis was performed using a square-root transformation. The sensitivity analysis confirmed only negligible differences between the transformed and raw scores, so analysis using raw scores is presented.

Results

Sample characteristics

Of 2665 respondents (2013: n=1247, 2014: n=1418), 2644 (99.2%) had complete age, sex and SDQ data. Among the children (aged 5-10 years), 1341 (98.1%) had complete diet information, and 1277 (93.4%) had complete activity information, while among adolescents (aged 11-15 years), 1257 (98.4%) had complete diet information and 1183 (92.6%) had complete activity information. Characteristics of the survey participants are summarised in Table 1. Males made up 50.0% of child and 51.1% of adolescent respondents. Most children met the fruit recommendations compared to just over half the adolescents, whilst only very small proportions across both age groups met vegetable intake recommendations. Physical activity recommendations, to be active 60 minutes or more each day, were met by 74.9% children and 66.9% of adolescents. Lower proportions of both children (65.6%) and adolescents (51.6%) met screen time recommendations.

Population level mean and median food intake and activity levels are presented in Table 2. Both children (aged 5-10 years) and adolescents (aged 11-15 years) consumed an average of two serves of fruit and two serves of vegetables per day. The median screen time for children per day was 1.5 hours (IQR=1.0-2.3), whilst adolescents spent approximately two hours a day in front of a screen (mean=2.1, SE=0.06, median=1.8, IQR (1.1-2.5)).

SDQ sub-scales

In the crude analysis, children (aged 5-10) who met the discretionary food recommendations, and both children and adolescents (aged 11-15) who met the screen time recommendations were significantly less likely to have any SDQ score in the at-risk range (Table 3). After adjustment for potential confounders, the significantly lower likelihood of any at-risk score on the SDQ remained only for meeting the screen time recommendations, in both children and adolescents (Table 3). Furthermore, meeting screen time recommendations was significantly associated with a reduced likelihood of an at-risk score in each of the SDQ sub-scales for children and two of the five subscales for adolescents (Table S2).

SDQ total difficulties score

The mean total difficulties score on the SDQ was 7.8 (SE = 0.25, median = 6.7, IQR = 3.8-10.4) for children (aged 5-10), and 7.4 (SE= 0.25, median = 5.8, IQR = 2.9-9.8) for adolescents (aged 11-15). Meeting the vegetable intake recommendations or screen time recommendations was significantly associated with a lower total difficulties score in both age groups after adjustment for potential confounders (Table 4). Meeting fruit recommendations in children and discretionary food intake in adolescents was also associated with a significantly reduced total difficulties score.

A multivariable analysis including all diet and activity indicators in a single model, adjusted for demographic factors, showed that after accounting for other health behaviours, only meeting screen time recommendations had a significant association with a lower total difficulties score in both age groups (Table 5). Meeting the vegetable intake recommendation was also significantly associated with a lower total difficulties score after adjusting for the other indicators, for adolescents only (Table 5). Model estimates for demographic confounders are provided in Table S3.

Discussion

Our secondary analysis indicates that NSW children and adolescents who have healthy lifestyle behaviours, especially appropriate screen time and healthier diets, are less likely to experience psychological difficulties. For children and adolescents who met recommendations for screen time there was a significant and consistent benefit in terms of a reduced SDQ total difficulties score. The results for diet were slightly different for adolescents and children and showed some variation in the effects of the different dietary behaviours but indicate a benefit for meeting at least some dietary recommendations. Since even a small increase in the SDQ total difficulties score has been shown to indicate increased risk of diagnosed mental health problems (30), maintaining a healthy lifestyle may prevent the development of psychological difficulties or mental health problems in children and adolescents.

We demonstrated that of all the included healthy lifestyle behaviours, screen time above recommended levels was most strongly associated with a higher total difficulties score and therefore risk for poorer mental health outcomes. This is in line with other studies which have shown a relationship between greater screen time and poorer quality of life, depression and other mental health problems (9, 34–36).

Amounts of screen time and mental health are related (3, 37), most probably bi-directionally: poorer initial mental health predicts higher screen time (and declining physical activity levels), whilst increases in anxiety are associated with increasing screen time (8, 38, 39). Compared to children, we identified that proportionally fewer adolescents met the screen time recommendations, in agreement other Australian population studies (22) and international findings (9). This reinforces adolescence as a particularly critical time for reducing mental health related risk behaviours.

We did not find a statistically significant association between physical activity and mental health, however we did observe a tendency for both children and adolescents who met physical activity recommendations to have lower SDQ scores. Some researchers have found evidence for an association between physical activity and lower rates of depression and anxiety, or more positive self-perceptions and self-esteem, but a review concluded that the evidence base is limited (3, 24). It may also be important to differentiate between types of physical activity since many studies showing a positive relationship used acute exercise sessions as the exposure variable (40) whereas we examined regular physical activity participation that met recommended levels. A similar need to examine activity types, intensity and contexts has been found in adult studies (41).

Adequate fruit and vegetable intake, and lower discretionary food consumption, were all associated with a lower total difficulties score, although somewhat differentially among children and adolescents. High discretionary food intake appears to be more important for the psychological health of adolescents, this is consistent with previous studies, which have also shown that discretionary foods play a significant role in adolescent mental health (42) (19, 20). In children, eating sufficient amounts of fruit was important for mental health, which has also been shown in a number of studies (2). A number of studies have found an association between an unhealthy diet and mental health in children and/ or adolescents, and while measures differed, high consumption of discretionary foods has often been used to define an unhealthy diet (4).

Few studies have examined in detail the contribution of fruit and vegetable consumption to good mental health (4). Oddy et al. noted a positive relationship for fruit and leafy green vegetables but not for other types of vegetables (20) while Renzaho et al found no relationship between vegetable consumption and SDQ scores, although they did not examine the effect of meeting guidelines for fruit and vegetables (43). Nevertheless, only a very small proportion of NSW children and adolescents are meeting the guidelines for vegetable consumption, consistent with our previous research in the Australian National Health Surveys (44), so our findings indicate that few children and adolescents are receiving the potential mental health benefits.

Over half of the children and adolescents met the screen time recommendations. This is based on parent self-report and it is likely that the amount of screen time use among children and adolescents in NSW is much higher than identified in the CPHS (22). Efforts should therefore be made to improve estimations of screen time use, particularly as the situation is likely to have worsened in recent years because of the proliferation of screen devices now used by children and adolescents. This study provides evidence of a

relationship between meeting recommendations for healthy lifestyle behaviours and having better results on the SDQ for NSW children aged 5–15 years, and supports the findings of previous studies about the importance of these lifestyle behaviours for mental as well as physical health in children and young people (2, 7, 16).

Strengths and limitations

A key strength of our study is that we used the results of a validated child psychological difficulties questionnaire in a population sample of children and adolescents to examine if there were associations with important regular healthy lifestyle behaviours. Our analysis adjusted for a wide range of socioeconomic and family factors (such as parent's education and single parent families) which are independently associated with diet, physical activity and overall healthy lifestyle. We also adjusted for BMI, as overweight and obesity is likely to be an important confounder in the diet and mental health relationship (45). These adjustments increase the reliability of our findings. We used the linear scale for the SDQ total difficulties score, rather than cut-offs for diagnosed mental health problems (30), since our aim was to examine whether differences in scores were associated with the healthy lifestyle behaviours. The SDQ is an appropriate tool for measuring psychological difficulties in children as it also captures issues less serious than diagnosed mental health problems, but the results can predict risk for the development of more serious problems. (30). The mean total difficulties score for our sample of NSW children was similar to the mean found for parent report in an earlier Australian study (31).

Our analysis, however, has some limitations. The proportions meeting the healthy food guidelines may have been slightly underestimated since the survey questions were unable to detect half serves and therefore the recommendations were increased to be a whole serve for a portion of the sample. In consumption guidelines for children, a serve of discretionary food is based on kilojoules, so the amount is different for each type of food and we were unable to take this into account. This may have resulted in underestimating the proportion of children meeting discretionary food guidelines. We were also not able to adjust for overall energy intake as this data was not collected.

Data were based on parent report, which may have over or underestimated diet and activity according to social desirability bias or lack of information (e.g. difficulty estimating physical activity during school hours). Self-reported data on screen time in adolescents shows a lower prevalence meeting guidelines (22), and psychological difficulties have been found more likely to be reported by children themselves compared to parents (31), suggesting that unhealthy behaviours and difficulties may have been underestimated.

In addition, there was a higher proportion of missing data for the screen time indicator (7%) compared to other variables and the questions used in 2012/2013 may not have adequately captured the full range of screen time activities, particularly leisure screen time on hand held devices, although this was likely far less common in 2012/2013 than now. Our data are cross-sectional and therefore reverse causality, or a bi-directional effect, cannot be ruled out.

Conclusions

Improving mental health and well-being among children and adolescents is a global health priority. Our research indicates that NSW children and adolescents who have better dietary behaviours and lower screen time have better psychological health. The strong association between appropriate screen time and better psychological health observed in this study is particularly important in view of rising concerns about the impact of screen time, particularly small screens, on children's mental health and well-being (10, 46). The results strengthen the evidence for the association between lifestyle behaviours and child mental health in Australia and globally, and highlight the importance of implementing policies and interventions to support children and families to achieve healthy lifestyles.

Declarations

Ethics approval and consent to participate

Ethical approval for the NSW Child Population Health Survey was provided by the NSW Population Health Services and Research Ethics Committee (AU RED Reference: HREC/11/CIPHS/55). Cancer Institute NSW reference number: 2011/09/349. A parent or care giver provided informed consent and answered the survey questions for a randomly selected child.

Consent for publication

Not applicable

Availability of data and materials

The data sets analysed during the current study are not publicly available due to NSW Government privacy restrictions and conditions of ethical approval.

Competing interests

There are no financial or non-financial competing interests to declare.

Funding

No specific funding was provided for this study, although this work was completed while HB and JGu were employed as trainees in the NSW Biostatistics Training Program funded by the NSW Ministry of Health. They undertook this work while based at the Prevention Research Collaboration, Charles Perkins Centre, Sydney School of Public Health, at The University of Sydney.

Author's contributions

SM and SB planned the study supported by JGa who designed the data analysis approach. MT contributed to the final design and data analysis approach. HB undertook the initial data analysis and

JGu continued the data analysis. HB drafted the original article. HB and JGu contributed to re-design and undertook data re-analysis and provided most biostatistical advice. MT oversaw re-analysis of the data later in the project. SM and MT re-drafted the paper and undertook reviews of the literature. All authors contributed to interpretation of the findings. All authors reviewed drafts of the paper and contributed to revised versions, including the submitted version.

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References

1. Mhrshahi S, Gow ML, Baur LA. Contemporary approaches to the prevention and management of paediatric obesity: an Australian focus. *Medical Journal of Australia*. 2018;209(6):267-74.
2. O'Neil A, Quirk SE, Housden S, Brennan SL, Williams LJ, Pasco JA, et al. Relationship Between Diet and Mental Health in Children and Adolescents: A Systematic Review. *American Journal of Public Health*. 2014;104(10):e31-e42.
3. Biddle SJ, Asare M. Physical activity and mental health in children and adolescents: a review of reviews. *British journal of sports medicine*. 2011;45(11):886-95.
4. Khalid S, Williams CM, Reynolds SA. Is there an association between diet and depression in children and adolescents? A systematic review. *British journal of nutrition*. 2016;116(12):2097-108.
5. Biddle SJ, Ciacconi S, Thomas G, Vergeer I. Physical activity and mental health in children and adolescents: An updated review of reviews and an analysis of causality. *Psychology of Sport and Exercise*. 2019;42:146-55.
6. Wu X, Zhuang L, Li W, Guo H, Zhang J, Zhao Y, et al. The influence of diet quality and dietary behavior on health-related quality of life in the general population of children and adolescents: a systematic review and meta-analysis. *Quality of Life Research*. 2019;28(8):1989-2015.

7. Dumuid D, Olds T, Lewis LK, Martin-Fernández JA, Katzmarzyk PT, Barreira T, et al. Health-related quality of life and lifestyle behavior clusters in school-aged children from 12 countries. *The Journal of pediatrics*. 2017;183:178-83. e2.
8. Herman KM, Hopman WM, Sabiston CM. Physical activity, screen time and self-rated health and mental health in Canadian adolescents. *Preventive medicine*. 2015;73:112-6.
9. Saunders TJ, Vallance JK. Screen time and health indicators among children and youth: current evidence, limitations and future directions. *Applied health economics and health policy*. 2017;15(3):323-31.
10. Houghton S, Hunter SC, Rosenberg M, Wood L, Zadow C, Martin K, et al. Virtually impossible: limiting Australian children and adolescents daily screen based media use. *BMC Public Health*. 2015;15(1):5.
11. Ghasemi SR, Rajabi Gilan N, Reshadat S, Hemati A. Investigating Health-Related Quality of Life and the Use of Media Technologies in Adolescents. *Journal of Mazandaran University of Medical Sciences*. 2019;29(171):81-91.
12. Suchert V, Hanewinkel R, Isensee B. Sedentary behavior and indicators of mental health in school-aged children and adolescents: A systematic review. *Preventive medicine*. 2015;76:48-57.
13. Hoare E, Milton K, Foster C, Allender S. The associations between sedentary behaviour and mental health among adolescents: a systematic review. *International journal of behavioral nutrition and physical activity*. 2016;13(1):108.
14. Sigman A. Time for a view on screen time. *Archives of disease in childhood*. 2012;archdischild-2012-302196.
15. Lawrence D, Johnson S, Hafekost J, Boterhoven de Haan K, Sawyer M, Ainley J, et al. The mental health of children and adolescents: Report on the second Australian child and adolescent survey of mental health and wellbeing. 2015.
16. Dimov S, Mundy LK, Bayer JK, Jacka FN, Canterford L, Patton GC. Diet quality and mental health problems in late childhood. *Nutritional Neuroscience*. 2019:1-9.
17. Kremer P, Elshaug C, Leslie E, Toumbourou JW, Patton GC, Williams J. Physical activity, leisure-time screen use and depression among children and young adolescents. *Journal of science and medicine in sport*. 2014;17(2):183-7.
18. Jacka FN, Kremer PJ, Leslie ER, Berk M, Patton GC, Toumbourou JW, et al. Associations between diet quality and depressed mood in adolescents: results from the Australian Healthy Neighbourhoods Study. *Australian and New Zealand Journal of Psychiatry*. 2010;44(5):435-42.
19. Jacka FN, Kremer PJ, Berk M, de Silva-Sanigorski AM, Moodie M, Leslie ER, et al. A prospective study of diet quality and mental health in adolescents. *PloS one*. 2011;6(9):e24805.
20. Oddy WH, Robinson M, Ambrosini GL, Therese A, de Klerk NH, Beilin LJ, et al. The association between dietary patterns and mental health in early adolescence. *Preventive medicine*. 2009;49(1):39-44.
21. Boylan S, Hardy L, Drayton B, Grunseit A, Mihrshahi S. Assessing junk food consumption among Australian children: trends and associated characteristics from a cross-sectional study. *BMC public*

- health. 2017;17(1):299.
22. Hardy L, Mihrshahi S, Drayton B, Bauman A. NSW Schools Physical Activity and Nutrition Survey (SPANS) 2015: Full Report. 2015.
 23. Sawyer SM, Afifi RA, Bearinger LH, Blakemore S-J, Dick B, Ezech AC, et al. Adolescence: a foundation for future health. *The Lancet*. 2012;379(9826):1630-40.
 24. Lubans D, Richards J, Hillman C, Faulkner G, Beauchamp M, Nilsson M, et al. Physical activity for cognitive and mental health in youth: a systematic review of mechanisms. *Pediatrics*. 2016;138(3):e20161642.
 25. NSW Health. Child Population Health Survey 2018 [Available from: <https://www.health.nsw.gov.au/surveys/child/Pages/default.aspx>].
 26. National Health and Medical Research Council (Australia). Australian Dietary Guidelines 2013. Available from: <https://www.nhmrc.gov.au/guidelines-publications/n55>.
 27. NHMRC. Australian Dietary Guidelines 2013 [Available from: https://www.nhmrc.gov.au/_files_nhmrc/file/your_health/healthy_nutrition/n55a_australian_dietary_guidelines_summary_131014_1.pdf].
 28. Department of Health. Australia's physical activity and sedentary behaviour guidelines. Fact Sheet: Children (5-12 years). In: Health AGDo, editor. 2018.
 29. Department of Health. Australia's Physical Activity and Sedentary Behaviour Guidelines. Fact Sheet: Young people (13-17 years). In: Health AGDo, editor. 2018.
 30. Goodman A, Goodman R. Strengths and difficulties questionnaire as a dimensional measure of child mental health. *Journal of the American Academy of Child & Adolescent Psychiatry*. 2009;48(4):400-3.
 31. Mellor D. Normative data for the Strengths and Difficulties Questionnaire in Australia. *Australian psychologist*. 2005;40(3):215-22.
 32. Australian Bureau of Statistics. Socio-Economic Indexes for Areas 2018 [Available from: <http://www.abs.gov.au/websitedbs/censushome.nsf/home/seifa>].
 33. Lumley T. Package 'survey'. 3.4.0 ed2017.
 34. Costigan SA, Barnett L, Plotnikoff RC, Lubans DR. The health indicators associated with screen-based sedentary behavior among adolescent girls: a systematic review. *Journal of Adolescent Health*. 2013;52(4):382-92.
 35. Hoare E, Skouteris H, Fuller-Tyszkiewicz M, Millar L, Allender S. Associations between obesogenic risk factors and depression among adolescents: a systematic review. *Obesity reviews*. 2014;15(1):40-51.
 36. Tremblay MS, LeBlanc AG, Kho ME, Saunders TJ, Larouche R, Colley RC, et al. Systematic review of sedentary behaviour and health indicators in school-aged children and youth. *International journal of behavioral nutrition and physical activity*. 2011;8(1):98.
 37. Pagani LS, Fitzpatrick C, Barnett TA, Dubow E. Prospective associations between early childhood television exposure and academic, psychosocial, and physical well-being by middle childhood.

- Archives of pediatrics & adolescent medicine. 2010;164(5):425-31.
38. Gunnell KE, Flament MF, Buchholz A, Henderson KA, Obeid N, Schubert N, et al. Examining the bidirectional relationship between physical activity, screen time, and symptoms of anxiety and depression over time during adolescence. *Preventive medicine*. 2016;88:147-52.
 39. Lissak G. Adverse physiological and psychological effects of screen time on children and adolescents: Literature review and case study. *Environmental research*. 2018;164:149-57.
 40. Álvarez-Bueno C, Pesce C, Cavero-Redondo I, Sánchez-López M, Martínez-Hortelano JA, Martínez-Vizcaíno V. The effect of physical activity interventions on children's cognition and metacognition: A systematic review and meta-analysis. *Journal of the American Academy of Child & Adolescent Psychiatry*. 2017;56(9):729-38.
 41. White RL, Babic MJ, Parker PD, Lubans DR, Astell-Burt T, Lonsdale C. Domain-specific physical activity and mental health: a meta-analysis. *American journal of preventive medicine*. 2017;52(5):653-66.
 42. Kulkarni A, Swinburn B, Utter J. Associations between diet quality and mental health in socially disadvantaged New Zealand adolescents. *European Journal of Clinical Nutrition*. 2015;69(1):79.
 43. Renzaho A, Kumanyika S, Tucker KL. Family functioning, parental psychological distress, child behavioural problems, socio-economic disadvantage and fruit and vegetable consumption among 4–12 year-old Victorians, Australia. *Health Promotion International*. 2011;26(3):263-75.
 44. Mhrshahi S, Myton R, Partridge SR, Esdaile E, Hardy LL, Gale J. Sustained low consumption of fruit and vegetables in Australian children: Findings from the Australian National Health Surveys. *Health Promotion Journal of Australia*. 2019;30(1):83-7.
 45. Halfon N, Larson K, Slusser W. Associations between obesity and comorbid mental health, developmental, and physical health conditions in a nationally representative sample of US children aged 10 to 17. *Academic pediatrics*. 2013;13(1):6-13.
 46. Twenge JM, Joiner TE, Rogers ML, Martin GN. Increases in depressive symptoms, suicide-related outcomes, and suicide rates among US adolescents after 2010 and links to increased new media screen time. *Clinical Psychological Science*. 2018;6(1):3-17.

Tables

Table 1. Survey sample characteristics, food and activity behaviours and emotional and behavioural problems from the NSW Child Population Health Survey, 2013-2014

Characteristic	5-10 yrs		11-15 yrs	
	N=1367		N=1277	
	<i>n</i>	%	<i>n</i>	%
Sex				
Male	684	50.0	653	51.1
Female	683	50.0	624	48.9
Mother's highest qualification ^S				
Year 10 certificate or diploma	143	11.2	195	16.3
Completed High School (HSC)	158	12.3	141	11.8
Tertiary certificate or diploma	363	28.3	383	32.1
University or other tertiary degree	619	48.3	475	39.8
Body Mass Index				
Overweight or obese	220	24.2	213	20.8
Single parent family	318	23.3	356	27.9
Remoteness				
Major cities	769	56.3	702	54.9
Regional or remote	598	43.7	576	45.1
Food and activity behaviours				
Met fruit recommendation	971	71.7	736	58.1
Met vegetable recommendation	80	5.9	60	4.8
Met discretionary food cut off	716	52.4	626	49.0
Met PA recommendation	1016	74.9	849	66.9
Met screen time recommendation	840	65.6	612	51.6
Emotional and behavioural problems				
Emotional symptoms	144	10.5	198	15.5
Conduct problems	105	7.7	85	6.7
Hyperactivity-inattention	163	11.9	124	9.7
Peer problems	105	7.7	167	13.1
Prosocial behaviour	28	2.1	37	2.9

Any problems ^β	333	24.3	338	26.5
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33 children (1.2%) missing data

§ 167 children (6.3%) missing data

^β At least one problem score in any of the SDQ scales

Note: there were higher levels of missing data for screen time (87 (6.3%) for 5-10 year olds and 91 (7.1%) for 11-15 year olds)

Table 2. Mean and median values for dietary and activity behaviours and total difficulties score, stratified by age.

Behaviour	5-10 yrs		11-15 yrs	
	Mean (SE)	Median (IQR)	Mean (SE)	Median (IQR)
Fruit serves per day	2.1 (0.04)	1.9 (1.0-2.6)	1.9 (0.07)	1.8 (0.9-2.0)
Vegetable serves per day	2.0 (0.05)	1.8 (0.9-2.9)	2.2 (0.06)	1.8 (0.9-2.9)
Discretionary food serves per day	0.6 (0.03)	0.0 (0.0-0.6)	0.7 (0.03)	0.0 (0.0-0.7)
PA hours per day	1.9 (0.06)	1.5 (0.9-2.3)	1.6 (0.06)	1.3 (0.7-2.1)
Screen time hours per day	1.8 (0.05)	1.5 (1.0-2.3)	2.1 (0.06)	1.8 (1.1-2.5)

Data has been weighted to be representative of the NSW population

Table 3. Unadjusted and adjusted odds ratios of having any emotional, behavioural or social problem as assessed by the Strengths and Difficulties Questionnaire (SDQ), by diet and physical activity indicators.

Factor	Any Problem		Any Problem	
	Unadjusted OR (95% CI)		Adjusted OR (95% CI)	
	5-10 yrs	11-15 yrs	5-10 yrs	11-15 yrs
Fruit serves per day	0.72 (0.49-1.05)	0.80 (0.55-1.18)	0.74 (0.45-1.24)	0.98 (0.62-1.54)
Vegetable serves per day	0.54 (0.23-1.25)	0.92 (0.41-2.07)	0.39 (0.13-1.16)	0.86 (0.31-2.35)
Discretionary food serves per day	0.60 (0.42-0.88)*	0.81 (0.55-1.19)	0.76 (0.47-1.25)	0.85 (0.51-1.25)
PA hours per day	0.84 (0.58-1.23)	0.69 (0.46-1.05)	0.90 (0.55-1.49)	0.68 (0.41-1.12)
Screen time hours per day	0.40 (0.27-0.59)*	0.54 (0.36-0.82)*	0.52 (0.32-0.87)*	0.48 (0.29-0.79)*

*p<0.05, each indicator was included in a separate model, adjusted for age, sex, BMI, mother's highest qualification, family structure (single parent family), and remoteness.

Table 4. Unadjusted and adjusted mean difference in total difficulties score, between those who met the diet, physical activity and lifestyle indicators and those who did not (adjusted for demographic factors).

Indicator	Unadjusted mean difference (95% CI)		Adjusted mean difference (95% CI)	
	5-10 yrs	11-15 yrs	5-10 yrs	11-15 yrs
Met fruit recommendation	-1.18 (-2.22,-0.15)*	-0.65 (-1.63,0.34)	-1.26 (-2.42,-0.10)*	0.00 (-1.06,1.05)
Met vegetable recommendation	-1.64 (-2.99,-0.30)*	-2.06 (-3.61,-0.51)*	-1.54 (-3.03,-0.05)*	-1.19 (-3.60,-0.39)*
Met discretionary food limit	-1.25 (-2.21,-0.29)*	-1.31 (-2.29,-0.34)*	-0.96 (-1.97,0.04)	-1.16 (-2.14,-0.18)*
Met PA recommendation	-0.90 (-1.91, 0.12)	-0.86 (-1.86,0.15)	-0.74 (-1.76,0.28)	-0.68 (-1.62,0.26)
Met screen time recommendation	-2.69 (-3.81,-1.57)*	-2.23 (-3.24,-1.21)*	-1.60 (-2.70,-0.50)*	-2.18 (-1.36,-1.20)*

*p<0.05, Each indicator was included in a separate model, adjusted for year of age, sex, BMI, mother's highest qualification, family structure (single parent family) and remoteness.

Table 5. Multivariable analysis of diet and activity factors predictive of total difficulties score in Strengths and Difficulties Questionnaire (SDQ) children/adolescents aged 5-15 years, stratified by age.

	Mean Total Difficulties Score Difference	
	5-10 yrs	11-15 yrs
Met fruit recommendation	-0.90 (-2.10, 0.30)	0.26 (-0.86, 1.38)
Met vegetable recommendation	-0.90 (-2.47, 0.66)	-1.77 (-3.53, -0.01)*
Met discretionary food limit	-0.67 (-1.74, 0.39)	-0.95 (-1.97, 0.08)
Met PA recommendation	-0.30 (-1.34, 0.74)	-0.44 (-1.42, 0.55)
Met screen time recommendation	-1.56 (-2.68, -0.44)*	-2.12 (-3.11, -1.12)***

*** = $P < 0.001$, ** = $P < 0.01$, * = $P < 0.05$. All factors were included in a single multivariable model, adjusted for age, sex, BMI, mother's highest qualification family structure (single parent family), and remoteness. Estimates for demographic factors are provided in Table S3.

Supplementary Files

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- [SupplementaryMaterial.docx](#)