Original Article

Influence of obesogenic behaviors on health-related quality of life in adolescents

Bamini Gopinath BTech, PhD[1], Jimmy CY Louie BSc MNutrDiet PhD[2], Victoria M Flood BSc, MPH PhD[2], George Burlutsky BSc, MApplStat[1], Louise L Hardy BA, MPH, PhD[3], Louise A Baur MBBS(Hons), BSc(Med), PhD, FRACP[4,5], Paul Mitchell MBBS, MD, PhD, FRANZCO, FRCOphth, FAFPHM[1]

[1]*Centre for Vision Research, Department of Ophthalmology and Westmead Millennium Institute, University of Sydney, NSW, Australia*
[2]*School of Health Sciences, University of Wollongong, Sydney, NSW, Australia*
[3]*Physical Activity, Nutrition and Obesity Research Group, University of Sydney, Sydney, NSW, Australia*
[4]*University of Sydney Clinical School, The Children's Hospital at Westmead, Sydney, NSW, Australia*
[5]*School of Public Health, University of Sydney, Sydney, NSW, Australia*

We aimed to prospectively examine the association between the combined effects of obesogenic behaviors on quality of life (QOL) in adolescents. Of 2353 Sydney schoolchildren surveyed (median age 12.7 years), 1,213 were re-examined 5 years later at age 17-18. Children completed activity and food-frequency questionnaires. An unhealthy behavior score was calculated, allocating 1 point for the following: <60 minutes of total physical activity/ day; ≥2 hours of screen time/ day; consumed salty snack foods and/or confectionery ≥5 times per week; ≥1 serves of soft drinks and/or cordial/ day; and not consuming both ≥2 serves of fruit and ≥3 serves of vegetables/ day. Health-related QOL was assessed by the Pediatric Quality of Life Inventory (PedsQL). The prevalence of 0, 1, 2, 3, 4, and 5 lifestyle risk factors was 4.2%, 17.1%, 30.7%, 30.5%, 13.9% and 3.6%, respectively. After multivariable-adjustment, children engaging in 5 versus 0 unhealthy behaviors had 9.2-units lower PedsQL physical summary score (p_{trend}=0.001), five years later. Boys reporting 4 or 5 lifestyle risk factors compared to their peers reporting none or one at baseline, had lower total and physical summary scores at follow-up, p_{trend}=0.02 and 0.01, respectively. Girls engaging in 4 or 5 versus 0 or 1 unhealthy behaviors, had 4.6-units lower physical summary score (p_{trend}=0.04), five years later. The number of obesogenic lifestyle risk factors was independently associated with subsequent poorer QOL, particularly physical health, during adolescence. These findings underscore the importance of targeting lifestyle behaviors to promote general well-being and physical functioning in adolescents.

Key Words: adolescents, quality of life, lifestyle, diet, Sydney Childhood Eye Study

INTRODUCTION

Health-related quality of life (QOL) refers to the subset of QOL directly related to an individual's health,[1] encompassing physical, mental, and social well-being.[2-4] Health-related QOL data have been used for a number of years to assess the population burden of illness and disability, to identify health disparities and needs, and to monitor changes over time.[5,6]

The importance of individual lifestyle habits for impaired health-related QOL in children and adolescents has been documented in population-based studies.[4,7,8] A Japanese study of adolescents assessed the association between individual lifestyle factors such as sleep duration, physical activity and snack intake on QOL over 10 years.[7] The authors found that shorter sleep duration, irregular snacks and physical inactivity at 3 years of age were associated with poorer QOL scores in adolescence. Recently, a Canadian cross-sectional study of 3,421 schoolchildren aged 10-11 years found that students with better diet quality and higher physical activity levels were significantly more likely to report better QOL scores.[8] Our group recently showed in a cohort of 2,353 Australian adolescents, that regular physical activity over 5 years was associated with a higher perceived health-related QOL.[4] Also in this study, lower QOL scores were observed among those adolescents who spent the most time in screen-viewing activities. In contrast, cross-sectional data from a UK study of 1,771 children aged 11-15 years showed that achieving the recommended physical activity and dietary guidelines were not associated with a significantly better QOL.[9]

Corresponding Author: Dr Bamini Gopinath, Centre for Vision Research, University of Sydney, Westmead Hospital, Hawkesbury Rd, Westmead, NSW, 2145, Australia.
Tel: 61 2 9845 5551; Fax: 61 2 9845 8345
Email: bamini.gopinath@sydney.edu.au
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Most previous childhood/ adolescence studies have focused on the effects of unhealthy lifestyle habits separately. The role of a combination of these modifiable lifestyle risk factors on health-related QOL in adolescence has not been examined, particularly in a prospective study. Hence, to address this gap in knowledge, we used a relatively large cohort of school-aged children followed from age 12 years through to adolescence at age 17-18 years, to assess whether there is a longitudinal association between the number of obesogenic behavioral risk factors (low fruit and vegetable intake, low physical activity, high screen time, high consumption of sweetened beverages, and high intake of energy-dense nutrient poor snacks) at baseline with health-related QOL five years later in adolescence, independent of potential confounders such as ethnicity, parental education and BMI. These epidemiological data could potentially help identify those adolescents who are at higher risk of poorer general well-being and who would benefit from targeted interventions.[10]

METHODS

Study population

The Sydney Childhood Eye Study is a population-based survey of eye conditions and other health outcomes in school children living within the Sydney Metropolitan Area, Australia. It was approved by the Human Research Ethics Committee, University of Sydney, the Department of Education and Training, and the Catholic Education Office, New South Wales, Australia.[11] We obtained informed written consent from at least one parent of each child, as well as verbal assent from each child before the examinations. Study methods have been previously described.[11] Briefly, students of median age 12.7 years in a stratified random cluster sample of 21 high schools across Sydney were eligible to participate. Stratification was based on socioeconomic status data from the Australian Bureau of Statistics. This included a proportional mix of public, private or religious high-schools. Data for the 12-year-old cohort were collected during 2004-5. Of the 3,144 eligible 12-year-old children, 2,367 were given parental permission to participate and 2,353 underwent examinations (74.9%). At the 5-year follow-up study (during 2009-11), 1,213 of 12-year old children (51.6% of the baseline participants) were re-examined at ages 17-18 years. While data on unhealthy lifestyle habits were acquired at both time points, QOL was only ascertained at the 5-year follow-up (ie in 2009-11).

Assessment of QOL

The PedsQL 4.0 was used to assess quality of life in pre-adolescents and adolescents, and was not originally administered at the baseline examination but administered at the follow-up study. The PedsQL is a validated 23-item questionnaire for children aged 2 to 18 years.[12] Mean scores are calculated based on a 5-point response scale for each item and transformed to a 0 to 100 scale with a higher score representing better quality of life. The PedsQL yields 3 summary scores: a total scale score, a physical health summary score and a psychosocial health summary score. There are 4 sub-scale scores: physical functioning, emotional functioning, social functioning and school functioning. The total score comprises the average of all items in the questionnaire. The psychosocial summary comprises the average of the items in the emotional, social and school functioning scales. The physical health summary score comprises the average of items in the physical functioning scale.[12]

Assessment of unhealthy lifestyle behaviors

Assessment of dietary data has been previously described.[13] Briefly, dietary data were collected using a 120-item self-administered food frequency questionnaire (FFQ), designed for specific use in Australian children and adolescents.[14] An allowance for seasonal variation of fruit and vegetables was made during analysis by weighting seasonal fruits and vegetables. The validity of the FFQ has been previously reported in children, specifically, correlation coefficients for comparative validity ranged from 0.03 for retinol to 0.56 for magnesium for transformed, energy-adjusted, de-attenuated nutrient data, with correlation coefficients greater than 0.40 for total fat, carbohydrate, sugars, vitamin C, folate and beta-carotene.[14] FFQ items were translated into daily food and nutrient intakes using a purpose built query in Microsoft Access 2007, with NUTTAB2006[15] as the source of nutrition composition. NUTTAB2006, however, does not provide the full range of nutrients of interest, for which we used values from other nutrient databases.[16,17] We also extracted data on the consumption of food groups including vegetables and fruits, as well as snack foods (e.g. chips, confectionery) which we termed as energy-dense, nutrient poor snacks. Data on the frequency of soft drink (non-diet or regular) and cordial (a sweet flavored concentrated syrup that is mixed with water to taste) consumption, were also obtained from this FFQ.

Assessment of physical activity and screen time in this cohort has also been previously reported.[4] Briefly, children self-reported the time usually spent in various physical pursuits in an average week (eg netball, athletics, soccer). The physical activities listed were those most commonly engaged in by this age group and represented those activities which are classified as having an energy expenditure of moderate-to-vigorous intensity, which is associated with health benefits.[4] The time spent in each activity was summed and the average hours/day calculated. For screen time, students were asked to think about an average week and to report the number of hours usually spent daily watching TV, playing video games, and using a computer (for fun and/or homework). The response categories were 'not at all; less than 1 hour/day; 1-2 hours/ day and; 3 or more hours/day.' Total screen time was the sum of time spent watching TV, playing video games and using a computer.

We constructed a lifestyle behavior index based on our previous report on another survey of Australian children.[10] Accordingly, low physical activity was defined as reporting <60 minutes of total physical activity per day. High screen time was defined as reporting ≥2 hours of screen time per day. A dichotomous variable representing high consumption of snack food was created using reported consumption of: salty snack foods (eg potato crisps or other salty snack such as corn crisps) and confectioneries (eg lollies, chocolate).[10] If the students' reported intake of salty snack foods or confectionery alone,

or both, was five or more times per week, they were classified as having a high snack food intake. High soft drink and/or cordial consumption was defined as having one or more per day. Finally, low fruit and vegetable intake was defined as not consuming two or more serves of fruit and three or more serves of vegetables per day. Each of the five obesogenic behavioral risk factors (i.e. low fruit and vegetable intake, low physical activity, high screen time, high soft drink intake, and high snack intake) were coded '1' for present and '0' for absent.

Assessment of potential confounders

Parents were asked to complete a comprehensive questionnaire which included socio-demographic information such as ethnicity, country of birth, highest level of parental education, and occupation. The ethnicity of the child was determined only if both parents shared that ethnic origin. Otherwise, children were placed in a mixed ethnicity category. Ethnicity was classified on the basis of self-identification by the parents, combined with information about the place of birth of the child. Ethnic categories were consistent with the Australian Standard Classification of Cultural and Ethnic groups:[18] 1) Caucasian included children from an European background; 2) East Asian covered children whose parents originated from China, Malaysia, Singapore, Indonesia, Philippines, Japan, Korea, Myanmar, Thailand, Laos, Cambodia, and Vietnam; 3) South Asian included Indian, Sri Lankan and Pakistani; 4) Middle Eastern; or 5) others/mixed (includes all other ethnicities).

Each child's weight was measured without shoes using a freestanding SECA height rod (Model 220, Hamburg, Germany). Weight in kilograms was measured using a standard portable weighing machine, after removing any heavy clothing. BMI was calculated as weight divided by height squared (kg/m^2).

Statistical analyses

Statistical analyses were performed using SAS (v9.2, SAS Institute, NC) including t-tests, chi-square tests and linear regression. General linear regression models (PROC GLM) were constructed to examine possible associations between combinations of modifiable lifestyle behaviors which were the independent variables with QOL, which was the dependent variable. Analysis of covariance was used to calculate mean PedsQL scores adjusted for age, sex, ethnicity, parental education and BMI. We also stratified all analyses by boys and girls given that there are widely recognized sex differences in the prevalence and correlates of diet, physical activity and screen time.[10] Given the reduction in numbers due to stratification, we combined those with 0 or 1 lifestyle risk factors and those with 4 or 5 lifestyle risk factors for sex-stratified analyses.

RESULTS

Of the 1,213 children examined, both at baseline and at follow-up, 742 were included for longitudinal analyses as these participants had complete dietary and physical activity data at baseline and PedsQL data at the 5-year examination. Table 1 shows the study characteristics of children included for prospective analyses. Children who engaged in five obesogenic lifestyle behaviors were more likely to be Caucasian but less likely to have tertiary qualified parents (Table 1). The prevalence of 0, 1, 2, 3, 4, and 5 obesogenic lifestyle risk factors was 4.2%, 17.1%, 30.7%, 30.5%, 13.9% and 3.6%, respectively.

General linear model (GLM) was used to adjust for age, sex, ethnicity, parental education and BMI, and showed that a combination of 5 compared with 0 lifestyle risk factors at baseline was associated with a lower physical summary score (p_{trend}=0.001) five years later in adolescence (Table 2). Significant associations were not observed between multiple obesogenic lifestyle behaviors and the PedsQL total score or any other domain scores.

In boys, a significant reduction in both total score and physical summary score was observed with multiple unhealthy behaviors, 4.5-units (p_{trend}=0.02) and 4.2-units (p_{trend}=0.01), respectively (Table 3). Girls engaging in 4 or 5 versus 0 or 1 lifestyle risk factors at baseline, had 4.6-units lower PedsQL physical summary score (multivariable-adjusted p_{trend}=0.04) at the 5-year follow-up. In girls, significant associations were not observed between multiple lifestyle risk factors with scores in the total score or other PedsQL domains (data not shown).

DISCUSSION

The current study contributes to new knowledge, as it examined the association between a combination of modifiable health behaviors and health-related QOL during adolescence. Schoolchildren engaging in all 5 obesogenic lifestyle behaviors compared with their peers who did not

Table 1. Study characteristics of Sydney Childhood Eye Study participants included in prospective analyses (n=742), stratified by the number of obesogenic lifestyle behaviors reported at baseline from 2004-5 to 2009-11

Characteristics	Number of lifestyle risk factors						*p*-value
	0 (n=31)	1 (n=127)	2 (n=228)	3 (n=226)	4 (n=103)	5 (n=27)	
Boys, %	15 (48.4)	58 (45.7)	124 (54.4)	110 (48.7)	57 (55.3)	11 (40.7)	0.43
Age, yrs	12.9 (0.5)	12.8 (0.4)	12.8 (0.5)	12.8 (0.4)	12.7 (0.4)	12.6 (0.4)	0.72
Ethnicity, %							
Caucasian	21 (67.7)	96 (75.6)	143 (62.7)	123 (54.4)	67 (65.1)	19 (70.4)	
East Asian	4 (12.9)	13 (10.2)	46 (20.2)	52 (23.0)	21 (20.4)	2 (7.4)	0.02
Middle Eastern	0 (0.0)	2 (1.6)	9 (4.0)	9 (4.0)	2 (1.9)	3 (11.1)	
Other	6 (19.4)	16 (12.6)	30 (13.2)	42 (18.6)	13 (12.6)	3 (11.1)	
Tertiary qualified parents, %	17 (54.8)	82 (64.6)	130 (57.0)	122 (54.0)	50 (48.5)	9 (33.3)	0.04
Body mass index, kg/m^2	18.8 (2.8)	20.2 (4.4)	19.8 (3.9)	20.2 (3.6)	19.2 (4.0)	19.0 (3.6)	0.06

Values are mean (SD) for continuous variables, and *n* (%) for categorical variables.

Table 2. Prospective association between the number of lifestyle risk factors at baseline (at age 12) and adjusted mean Pediatric Quality of Life Inventory (PedsQL) scores 5 years later (at age17-18) in the Sydney Childhood Eye Study (n=742)

PedsQL domains, adjusted mean (SE) †	Number of lifestyle risk factors						β†‡ (*p* for trend)
	0 (n=31)	1 (n=127)	2 (n=228)	3 (n=226)	4 (n=103)	5 (n=27)	
Total score	85.2 (2.3)	81.8 (1.4)	81.1 (1.2)	80.3 (1.2)	79.8 (1.5)	81.5 (2.6)	-0.77 (0.05)
Physical summary	97.5 (2.4)	93.3 (1.4)	92.1 (1.1)	90.2 (1.1)	90.2 (1.5)	88.3 (2.6)	-1.45 (0.001)
Psychosocial summary	79.0 (2.8)	76.2 (1.7)	75.6 (1.4)	75.2 (1.4)	74.6 (1.8)	78.2 (3.1)	-0.43 (0.37)
Emotional	78.5 (3.7)	73.2 (2.2)	74.1 (1.8)	74.2 (1.8)	73.6 (2.3)	76.5 (4.1)	-0.12 (0.85)
Social	93.2 (2.7)	90.7 (1.6)	88.8 (1.3)	90.3 (1.3)	88.9 (1.7)	87.9 (2.9)	-0.54 (0.24)
School	65.7 (4.1)	65.5 (2.4)	64.6 (2.0)	61.9 (2.0)	62.0 (2.6)	70.6 (4.5)	-0.64 (0.36)

† Adjusted for age, sex, ethnicity, body mass index, parental education.
‡ Beta (β) coefficients indicating the slope of the relationship between lifestyle risk factors and each PedsQL domain

Table 3. Prospective association between the number of lifestyle risk factors at baseline and adjusted mean Pediatric Quality of Life Inventory (PedsQL) scores in boys from the Sydney Childhood Eye Study, from 2004-5 to 2009-11 (n=375)

PedsQL domains, adjusted mean (SE) †	Number of lifestyle risk factors				β†‡ (*p* for trend)
	0 or 1 (n=73)	2 (n=124)	3 (n=110)	4 or 5 (n=68)	
Total score	84.7 (1.8)	82.7 (1.5)	82.1 (1.6)	80.2 (1.8)	-1.37 (0.02)
Physical summary	97.3 (1.6)	95.6 (1.3)	93.1 (1.3)	93.1 (1.6)	-1.57 (0.01)
Psychosocial summary	78.2 (2.3)	76.1 (2.0)	76.6 (2.0)	73.6 (2.3)	-1.21 (0.09)
Emotional	79.3 (2.8)	77.3 (2.4)	78.0 (2.4)	73.9 (2.8)	-1.39 (0.14)
Social	90.0 (2.2)	87.7 (1.8)	90.3 (1.9)	85.6 (2.2)	-0.80 (0.31)
School	65.3 (3.5)	63.6 (2.9)	61.6 (3.0)	61.6 (3.5)	-1.34 (0.22)

† Adjusted for age, ethnicity, body mass index, parental education.
‡ Beta (β) coefficients indicating the slope of the relationship between lifestyle risk factors and each PedsQL domain

engage in any of these behaviors at baseline, had poorer PedsQL physical summary score, five years later during adolescence. This association was independent of the influences of BMI, and socio-economic indicators such as parental education. Boys reporting 4 or 5 versus 0 or 1 lifestyle risk factors had significantly lower total PedsQL and physical summary scores, five years later. In girls, there was a significant combined effect of obesogenic lifestyle behaviors on the PedsQL physical summary score only.

We found that 19% of boys and 23% of girls engaged in one or none of the five obesogenic behavioral risk factors at baseline. This is similar to the previously observed prevalence of 22% and 30% of Australian boys and girls, respectively, who reported one or none of the lifestyle risk factors.[10] Also, a US study of adolescents aged 11-15 years reported that nearly 80% had multiple risk behaviors and only 2% met guidelines for physical activity, television viewing and servings of fruit and vegetables.[19] This is comparable to the 96% of schoolchildren in our cohort that had one or more obesogenic factors. The high prevalence of multiple poor health behaviors in our adolescent cohort, confirms data from other studies showing that most schoolchildren fail to meet multiple dietary and physical activity recommendations.[19] These findings underscore the importance of developing effective interventions to help adolescents improve their lifestyle and dietary habits. Despite health promotion programs frequently targeting multiple obesogenic risk factors, little is known about the best approaches to stimulating multiple health behavior change in adolescents.[19]

The temporal association between a combination of multiple obesogenic behaviors and lower PedsQL scores, concurs with an adult study that showed the accumulation of lifestyle risk factors was strongly associated with poorer general health and physical functioning.[20] It is likely that youth in this study with healthier behavioral patterns are more likely to report more positive perceptions of their health, in keeping with prior studies.[21] It is also possible that their family environment is supportive, facilitating healthier eating habits and behaviors.[22] Diets which include greater consumption of fruits and vegetables have been shown to have a beneficial impact on health-related QOL of adults and children.[7,23] Moreover, we previously showed that more time spent in physical activity and less screen time was associated with higher total PedsQL scores among adolescents.[4]

Boys and girls reporting 4 or 5 obesogenic risk factors at baseline were at a greater risk of poorer functioning in the physical dimension of the PedsQL. This association is most likely driven by leading a physically inactive lifestyle, as this is the group of adolescents most likely to report limitations in basic activities of daily living such as walking several blocks and lifting.[4] Excessive recreational screen time could also influence physical functioning, particularly as a prior study demonstrated that frequent screen time is related to poorer physical health.[24] For example, this could be because screen time potentially displaces physical activity which in turn reduces overall physical capabilities.[4,24,25] Alternatively, the link between unhealthy behaviors and poor physical health could be explained by poor dietary habits. Fruit and vegetable consumption could influence physical health through several pathways relating to numerous biologically active components. These may, for example, be short-term through influencing bowel habits.[26] A UK adult study reported a

direct significant association between fruit and vegetable consumption and self-reported physical functional health and a less consistent relationship with mental health.[26] Further, a randomized controlled trial in adults showed that an increase in fruit and vegetable consumption was associated with a change in physical health but not mental functioning.[27] Given that reduced physical functioning predicts adverse health outcomes,[27] the observed impact of multiple unhealthy behaviors on physical well-being could be important in terms of later adult health.

Our findings could have important public health implications, given that adolescence involves many major physical, social and psychological changes.[22] Additionally, interventions addressing multiple lifestyle behaviors may hold greater promise than those aimed at isolated behaviors.[28,29] Hence, findings from this study highlight the importance of planning evidence-based health promotion programs aimed at preventing adolescents from initiating an unhealthy lifestyle and which foster risk-reduction and cessation skills in those already engaged in such obesogenic health behaviors.[5] For example, a comprehensive school health approach that integrates nutrition education, nutrition policy, healthy food services and various physical activity strategies into a whole school model,[8] could contribute to potential improvements in youth QOL in the long-term. We caution, however, that our results need to be replicated in other adolescent cohort studies, and further studies are warranted to establish how these obesogenic lifestyle behaviors co-vary over time and predict poorer health-related QOL as adolescents transition into adulthood.

One of the strengths of this study is that it investigated the summative effect of obesogenic lifestyle behaviors, while most other adolescent cohorts have focused on the link between single health behaviors and health-related QOL. Other strengths include its longitudinal design, random cluster sample of a relatively large number of schoolchildren and use of a validated pediatric health-related QOL instrument.[4] The present study also has some limitations. First, although ours is a cohort study, only demographic, diet, screen time and physical activity data but not PedsQL data were collected at the baseline survey. Hence, we cannot determine the association between multiple obesogenic lifestyle risk factors with health-related QOL at age 12, nor can we determine changes in health-related QOL over the 5 years. Second, while we adjusted for a number of important confounders, we cannot disregard the possibility that other unmeasured factors such as societal factors and parental health behaviors could have influenced our findings. For instance, self-reported health outcomes could be particularly susceptible to social desirability bias,[30] however, in the current study we did not administer any scales that measure the influence of potential socially desirable responses.[30] Third, in children, FFQs are known to commonly over-report dietary intake, and in general are not able to capture energy intake reliably.[31] Nevertheless, we had taken steps in the FFQ data cleaning process to exclude participants who were under- or over-reporters. Finally, we need to caution about the generalisability of our findings. Our study sample was predominantly Caucasian and not a random sample of the wider Australian population. While we examined children of East and Southeast Asian, and Middle Eastern ethnicities, we had a very low proportion of other ethnic groups e.g., Indigenous Australians.

In conclusion, we show that a higher number of obesogenic lifestyle behaviors were associated with subsequent poorer health-related QOL during adolescence. This association was stronger for the physical domain of the PedsQL among boys and girls. These findings could contribute to the evidence-base for planning multifaceted intervention strategies that promote a combination of healthy eating and active living, which will not only help maintain a healthy weight status but also improve the QOL of adolescents.

AUTHOR DISCLOSURES

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Conflict of interest

None to declare

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Original Article

Influence of obesogenic behaviors on health-related quality of life in adolescents

Bamini Gopinath BTech, PhD[1], Jimmy CY Louie BSc MNutrDiet PhD[2], Victoria M Flood BSc, MPH PhD[2], George Burlutsky BSc, MApplStat[1], Louise L Hardy BA, MPH, PhD[3], Louise A Baur MBBS(Hons), BSc(Med), PhD, FRACP[4,5], Paul Mitchell MBBS, MD, PhD, FRANZCO, FRCOphth, FAFPHM[1]

[1]*Centre for Vision Research, Department of Ophthalmology and Westmead Millennium Institute, University of Sydney, NSW, Australia*
[2]*School of Health Sciences, University of Wollongong, Sydney, NSW, Australia*
[3]*Physical Activity, Nutrition and Obesity Research Group, University of Sydney, Sydney, NSW, Australia*
[4]*University of Sydney Clinical School, The Children's Hospital at Westmead, Sydney, NSW, Australia*
[5]*School of Public Health, University of Sydney, Sydney, NSW, Australia*

肥胖行為對青少年健康相關生活品質之影響

本研究是前瞻性研究，目的是探討容易造成肥胖的行為對青少年生活品質(QOL)的綜合效應之間的關聯性。研究對象來自雪梨學童調查，共 2,353 位學童(年齡中位數為 12.7 歲)，5 年後有 1213 位，於 17-18 歲被再次調查。學童完成活動及飲食頻率問卷。不健康的行為計算其得分，指定分數 1 點如下：每天小於 60 分鐘的體能活動；每天超過 2 小時看螢幕；每週攝取 5 次以上鹹味零食和/或糖果；每天攝取 1 份以上碳酸飲料和/或甜香酒；每天沒有攝取 2 份以上的水果和 3 份以上的蔬菜。健康有關的生活品質是由兒童生活品質問卷(PedsQL)所評估。生活型態危險因子有 0、1、2、3、4 及 5 項的盛行率分別為 4.2%、17.1%、30.7%、30.5%、13.9%及 3.6%。在多變項調整後，追蹤 5 年結果發現，兒童有 5 項不健康行為比起 0 項者，在 PedsQL 中，體能總分低 9.2 個單位(p_{trend}=0.001)。男孩有 4 項或 5 項生活型態危險因子，相較於同年齡在基準點沒有或有 1 項危險因子者，在追蹤後，有較低整體及體能總分，趨勢的 p 值分別為 0.002 及 0.01。女孩在 5 年後的追蹤，有 4 項或 5 項生活型態危險因子比起沒有或有 1 項者，在體能總分低 4-6 個單位(p_{trend}=0.004)。學童容易造成肥胖的生活型態危險因子的項目多寡與後續的生活品質較差是獨立相關，尤其是青春期的體能健康。這些研究結果，強調針對青少年生活型態的行為，對於促進一般健康和體適能的重要性。

關鍵字：青少年、生活品質、生活型態、飲食、雪梨兒童眼科研究