European Psychiatry 61 (2019) 79–84

Contents lists available at ScienceDirect

European Psychiatry

journal homepage: http://www.europsy-journal.com

Original article

Lifestyle behavioural risk factors and emotional functioning among schoolchildren: The Healthy Growth Study

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ARTICLE INFO

Article history:
Received 22 May 2019
Received in revised form 17 July 2019
Accepted 19 July 2019
Available online 1 August 2019

Keywords:
Schoolchildren
Emotional health
Diet
Physical activity
Population-level

ABSTRACT

Background: There is an increasing focus on lifestyle as a factor in the pathogenesis of mental health disorders; however, this has been relatively underexplored in child populations. This study aimed to assess the relationships between behavioural lifestyle factors and emotional functioning in a large, population-representative sample of schoolchildren in Greece.
Methods: A representative sample of 2,240 schoolchildren, aged 9–13 years, participated in the Healthy Growth Study during 2007–2010. Emotional functioning was measured using the Dartmouth COOP Functional Health Assessment charts/World Organization of Family Doctors Charts. A score of 3 or higher out of 5 indicated poorer emotional functioning. Participants self-reported dietary intake via three 24-h dietary recalls; fruit, vegetable and soft drink consumption were the dietary variables of interest. Participants' self-reported daily time spent in moderate to vigorous physical activity, and watching TV or playing video games were used to assess physical activity and sedentary behaviour.
Results: In fully adjusted models, females were at a greater risk of experiencing impaired emotional functioning compared to males (OR 1.76, 95%CI 1.44, 2.15, $p < 0.01$). Overweight/obesity compared to normal body weight (OR 1.52, 95%CI 1.31, 1.77, $p < 0.01$) was associated with poorer emotional functioning. Three hours or more of daily average physical activity compared to less than one hour (OR 0.59, 95%CI 0.40, 0.86, $p < 0.01$) was associated with improved emotional functioning. Consuming soft drinks compared to non-consumption (OR 1.24, 95%CI 1.02, 1.51) was associated with poorer emotional functioning; this became non-significant after corrections for multiple comparisons were made. Clustering of municipalities was accounted for in all models.
Conclusions: Whilst findings were cross-sectional and causality cannot be inferred, this study highlights the interdependence of emotional and physical functioning in schoolchildren. This points to the potential for targeting shared risk factors for both physical chronic diseases and emotional and mental health conditions among children. Further longitudinal evidence will identify the potential for such shared intervention targets. Adopting a comprehensive, integrated approach to children's emotional, mental, and physical health is warranted.

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http://dx.doi.org/10.1016/j.eurpsy.2019.07.002
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https://doi.org/10.1016/j.eurpsy.2019.07.002 Published online by Cambridge University Press

1. Introduction

Common mental disorders, such as anxiety and depression, are highly prevalent globally. On-going research is seeking to understand the risk factors and causal pathways during childhood and adolescence that increase the risk of current and future mental health problems [1]. Consistent population-level evidence supports the role of lifestyle behaviours in the development and maintenance of mental health problems, although this evidence has primarily been conducted among adolescents and adults. Understanding the relationship between dietary and physical activity behaviours and mental and emotional health during early years holds great public health potential on a global scale [2]. With international efforts to determine how to curb growing childhood obesity rates, and the large chronic disease burden attributed to lifestyle factors established in early life, there is a good potential for health benefits of healthful nutrition and physical activity regarding both physical and mental health outcomes [2].

Recent meta-analyses confirm diet quality as a determinant of depression risk in adults [3] and another recent meta-analysis of randomized controlled trials has shown that dietary interventions significantly reduce symptoms of depression across the general population [4]. The more limited evidence regarding dietary habits, nutritional status and mental health among children to date has been summarised in systematic reviews [5,6]. Overall, the cross-sectional evidence suggests unhealthy dietary patterns (characterised as 'junk foods', Western-diets, 'extras' foods) is significantly associated to poorer mental health (including depression, low mood and anxiety) among children. Longitudinally, there is a consistent relationship between healthful diets (increased fruits and vegetables, unprocessed, nutrient-dense foods) and improved mental health status as well as some evidence for poorer dietary quality and poorer mental health outcomes [5,6]. There are significant limitations to the available evidence in younger age-groups, including the failure to account for socio-economic circumstances (known to impact upon mental health outcomes and food-related behaviours) and other lifestyle behaviours. Critically, most of the available evidence has emerged from USA, United Kingdom, Australia and Canada, and focused on adolescence as opposed to child populations [7]. There is a need to examine such relationships in culturally diverse and younger-aged populations.

The relationship between physical activity and mental health in young people is well established [8–10], and likely driven by multiple factors including the neurobiological responses to exercise [11], the social and relationship-building opportunities afforded by physical activity, and an increase in the sense of achievement and self-esteem [8–10]. Indeed, meta-analyses of randomized controlled trials have convincingly demonstrated that increasing physical activity can provide effective treatment for young people with clinical depression [12]. It has been discussed that while physical activity may enhance psychological well-being, increased engagement in sedentary behaviours associated with modern society may also negatively impact on well-being, independently of exercise itself. For instance, screen use among young people has previously been shown to significantly relate to lower scores of self-esteem, reduced pro-social behaviours, and lower academic achievement [8,13].

We sought to strengthen the epidemiological evidence for the relationships between diet- and physical activity-related behaviours, and chronic mental and physical disease, and investigate these relationships for the first time among school-aged children population based in Greece. Population-level evidence is needed to inform prevention strategies to reduce the burden associated with lifestyle driven conditions and mental and physical illness at the national and international level, and this will be the first study to examine such relationships in the Greek schoolchildren population. Specifically, this study aims to identify the relationship between health behaviours such as the consumption of fruits, vegetables and soft drinks, time spent in moderate to vigorous physical activity and daily time spent using screens, as well as overweight/obesity, and the emotional functioning of schoolchildren in Greece.

2. Methods

2.1. Study design

The Healthy Growth Study has been reported in detail elsewhere [14,15]. Briefly, the Healthy Growth study was a large, epidemiological assessment of school-children in Greece aged 9 to 13 years. Participants were recruited via schools through a random, multi-staged, stratified method from the municipalities of Attica, Aetoloakarnania, Thessaloniki and Heraklion. The National Statistical Service of Greece was used to stratify school regions based on parent's education level and total population of students attending schools. Parental consent was obtained and subsequently 2655 out of 4145 school children (response rate 64.1%) participated in data collection including full medical examination (i.e anthropometric and body measurement, blood collection, clinical examination). All procedures received approval from Harokopio University Ethics Committee and from the Greek Ministry of National Education.

2.2. Measures

2.2.1. Emotional functioning

The Dartmouth COOP Functional Health Assessment charts/World Organization of Family Doctors (COOPS/WONCA) [16] was used to assess health-related quality of life from which the following item assessed emotional functioning; '*During the past 2 weeks, how much were you pre-occupied with emotional problems such as feeling anxious, depressed, irritable or downhearted and sad*?'. Participants responded 'not at all = 1', 'slightly = 2', 'moderately = 3', 'quite a bit = 4', 'extremely = 5' and higher scores reflected poorer emotional functioning and suspected presence of depressive symptoms. The five response choices were dichotomised into; 'good' score 1-2 equated improved emotional functioning, and 'poor' score 3-5 equated poorer emotional functioning, as consistent with previous research of children this age [17]. The cut-off score of 3 for this item used in our current study has previously shown good psychometric properties in accordance with elevated depressive symptoms suggesting depression [18]. The COOPS/WONCA questionnaire has been translated into numerous languages and validated in several countries [19–21].

2.2.2. Lifestyle behaviours

Dietary intake was measured via three 24-h recall morning interviews conducted by trained dietitians and nutritionists with school children. Dietary intake on two consecutive weekdays and one weekend day were reported. Participants were asked to describe the type and amount of foods and drinks consumed during the previous day. Food groups (i.e fruit, vegetables, soft drinks) were established using primary ingredients and nutritional content, which were converted to consumption in grams per day. Physical activity was assessed using a standardised activity questionnaire which has previously shown good reliability and validity [22]. Participants reported time spent in moderate to vigorous physical activity that they typically engaged in on two weekdays and one weekend day, which was converted to average hours per day. Participants were also asked to report their average time spent on sedentary activities including watching TV, DVDs, videos, and using computer for recreational use over a weekday

https://doi.org/10.1016/j.eurpsy.2019.07.002 Published online by Cambridge University Press

and weekend day, which was converted into a mean daily average of screen time. Height and weight were assessed by trained researchers in anthropometric body measurements, which was converted into body mass index from which the International Obesity Taskforce cut-off points were used to dichotomise into normal weight and overweight/obesity.

2.2.3. Covariates

School socio-economic level was derived from data provided by the National Statistical Service of Greece. More specifically, all municipalities from which schools were recruited were divided into 3 groups based on the average educational level of their adult population (25 to 65 years old). This procedure yielded two parental education cut-off points that allowed us to categorize municipalities into 3 groups of different socio-economic level, i.e. Higher, Medium and Lower.

2.3. Statistical analysis

All calculations were conducted in Stata Corp Version SE/15.0. Proportions were calculated for all demographic and health-related characteristics and differences in males and females were assessed using chi-square and independent samples *t*-test as appropriate. Logistic regression models were run to assess experiencing poorer emotional functioning (=1) compared to improved emotional functioning (=0), as per the COOPS/WONCA Chart scale. Each independent variable (lifestyle behaviour) was assessed in separate models, unadjusted (Model 1) and adjusted for age and sex (Model 2), school socio-economic level (Model 3), and weight status (Model 4). Bonferroni correction for multiple comparisons was applied and the accepted level of significance was $p < 0.01$. Clustering at municipality level was accounted for in all models.

3. Results

The proportion of males and females who participated and were subsequently included in this study were similar; however, there was a larger proportion of older aged-children overall (58% aged 11–13 years, vs. 42% aged 9–11 years), although this was non-significant ($p = 0.803$) (Table 1). The proportion of overweight/obesity was 42%, and this proportion was 45% among males and 39% among females. Underweight was found in less than 5% of children thus were combined with normal weight category. Overall, a quarter of school-children scored as having poorer emotional status, this proportion was higher among females (32%) compared to males (22%) ($p = 0.000$).

In fully adjusted models, being female and being categorised as overweight/obese was significantly associated with reporting poorer emotional functioning (Table 2). School-children who reported consuming a soft drink on the previous day were also at higher odds of being categorised as having poorer emotional functioning, however this result was non-significant after Bonferroni corrections were made. Increased physical activity was associated with reduced odds of experiencing poorer emotional functioning. There was an inverse relationship between physical activity levels and emotional functioning, with the strongest protective association observed in school children who reported 3 h or more of physical activity on the previous day compared to children who reported less than one hour of activity. There were no associations observed between the consumption of fruits or vegetables and emotional functioning. Further post-hoc analyses revealed no changes in findings when all lifestyle variables were included in a single model (Supplementary Table 1), suggesting unique and distinct relationships between the behaviours and emotional functioning. Overweight/obesity was combined based on their dual relevance to child health and as typically done in health behavioural research [23], and analyses revealed no changes in findings when weight status categories were separated (not reported).

4. Discussion

Females were at increased risk of poor emotional functioning, as were overweight/obese children. Whilst the healthful dietary behavioural items were non-significant in relation to emotional functioning increased physical activity was related to reduced odds of poor emotional functioning status.

The non-significant association between diet and emotional functioning was somewhat unexpected due to the evidence supporting consumption of nutrient dense foods and improved mental health status [5,6]. Much of the wider evidence to date reporting on the diet and mental health relationship has emerged from adult populations [3]. It is possible that the social and environmental drivers of dietary behaviours may be different for children, who are primarily dependent on caregivers for food, compared to adults [24]. It is also likely that dietary intake items used in this study failed to capture the overall dietary patterns of participants. Dietary patterns are widely recommended for the investigation of the diet and mental health relationship. This is due to individual intake of specific foods or nutrients failing to reflect the habitual behaviours that are more likely to contribute overall to the physiological mechanistic pathways that contribute to mental and emotional health [25]. Our findings are limited by the investigation of individual food consumption only. We also consider that the potential relationship between fruit and vegetable consumption and emotional health may have been attenuated by a greater proportion of young people adhering to a Mediterranean-style diet, which has been shown to promote positive mental and brain health [3]. Whilst assessment of such dietary pattern was outside the scope of this work, the adherence to such diets among young people in Greece has been reported to be low [26]. Fruit and vegetable consumption among children in Greece has been shown to be comparable to other countries of similar economic profile [27]. Therefore, we do not expect that this hypothesis explains the null finding. It is of further interest that consuming soft drinks was unrelated to poorer emotional functioning. Soft drinks are consistently included as a component of unhealthy diet patterns. It has been previously suggested that soft drinks could be considered a proxy for overall unhealthy dietary patterns [28]. Although not confirmed in these findings, this may have provided evidence for consistency of these findings with the wider evidence base for unhealthy dietary patterns being associated with poorer mental and emotional health.

Table 1
Participant characteristics of schoolchildren in the Healthy Growth Study.

	Males	Females	Total	p*
Age	n (%)	n (%)	n (%)	p = 0.803
9–11 years	466 (41.6)	461 (41.1)	927 (41.4)	
11–13 years	653 (58.4)	660 (58.9)	1,313 (58.6)	
School socio-economic area				p = 0.966
Lower	301 (26.9)	296 (26.4)	597 (26.7)	
Medium	375 (33.5)	378 (33.7)	753 (33.6)	
Higher	443 (39.6)	447 (39.9)	890 (39.7)	
Weight status				p = 0.006
Normal weight	619 (55.3)	684 (61.0)	1303 (58.2)	
Overweight/obese	500 (44.7)	437 (39.0)	937 (41.8)	
Emotional functioning				p = 0.000
Good	877 (78.4)	762 (68.0)	1639 (73.2)	
Poor	242 (21.6)	359 (32.0)	601 (26.8)	

* $p < 0.05$ for difference between males and females.

https://doi.org/10.1016/j.eurpsy.2019.07.002 Published online by Cambridge University Press

Table 2
Logistic regression models for emotional functioning (COOPS/WONCA Chart scores; 1/2=good, 3/5=poor) and behavioural and biomedical lifestyle factors, unadjusted and adjusted for gender, sex (Model 1), School SEL (Model 3) and weight status (Model 4), accounting for clustering of municipalities.

		Good *COOPS/WONCA = 1/2*	Poor *COOPS/WONCA = 3/5*	Model 1 (univariate)	Model 2 (+ [a]ge, sex)	Model 3 (+ [a]ge, sex, SEL)	Model 4 (+[a]ge, sex, SEL, weight st[a]tus)
Variable		n(%)	n(%)	OR (95%CI)	OR (95%CI)	OR (95%CI)	OR (95%CI)
Sex[a]	Males	877 (53.5)	242 (40.3)	Ref.	Ref.	Ref.	Ref.
	Females	762 (46.5)	359 (59.7)	**1.71 (1.40, 2.08)**	**1.71 (1.40, 2.08)**	**1.71 (1.40, 2.08)**	**1.76 (1.44, 2.15)**
Weight status[b]	Normal weight	994 (60.7)	309 (51.4)	Ref.	Ref.	Ref.	Ref.
	Overweight/obese	645 (39.3)	292 (48.6)	**1.46 (1.24, 1.71)**	**1.51 (1.30, 1.76)**	**1.52 (1.31, 1.77)**	**1.52 (1.31, 1.77)**
Fruit consumption	Non-consumer	683 (41.7)	237 (39.4)	Ref.	Ref.	Ref.	Ref.
	Consumer	956 (58.3)	364 (60.6)	1.10 (0.90, 1.33)	1.08 (0.90, 1.30)	1.07 (0.88, 1.30)	1.07 (0.89, 1.28)
Vegetable consumption	Non-consumer	357 (21.8)	127 (21.1)	Ref.	Ref.	Ref.	Ref.
	Consumer	1,282 (78.2)	474 (78.9)	1.04 (0.87, 1.24)	1.00 (0.83, 1.21)	0.99 (0.79, 1.25)	1.00 (0.84, 1.20)
Soft drinks	Non-consumer	998 (60.9)	339 (56.4)	Ref.	Ref.	Ref.	Ref.
	Consumer	641 (39.1)	262 (43.6)	1.20 (1.01, 1.43)*	1.24 (1.03, 1.48)*	1.22 (1.00, 1.47)*	1.24 (1.02, 1.51)*
Daily physical activity	Less than 1 hour per day	864 (52.7)	360 (59.9)	Ref.	Ref.	Ref.	Ref.
	1 - <2 hours	484 (29.5)	166 (27.6)	0.82 (0.63, 1.07)	0.89 (0.67, 1.17)	0.86 (0.65, 1.13)	0.88 (0.66, 1.16)
	2 - <3 hours	188 (11.5)	51 (8.5)	0.65 (0.44, 0.96)	0.77 (0.52, 1.13)	0.74 (0.50, 1.07)	0.76 (0.52, 1.11)
	3 hours or more	103 (6.3)	24 (4.0)	**0.56 (0.38, 0.83)**	**0.61 (0.41, 0.88)**	**0.58 (0.40, 0.86)**	**0.59 (0.40, 0.86)**
Daily screen time (TV/playing video games)	Total daily hours M(SD)	2.99 (1.79)	3.18 (1.81)	**1.06 (1.01, 1.11)**	1.05 (1.00, 1.10)*	1.05 (1.00, 1.11)*	1.05 (1.00, 1.09)

[a] Sex was omitted from Model 2–4.
[b] Weight status was omitted from Model 2–4. Bolding indicates significance at $p < 0.01$.
* Indicates significant prior to Bonferroni correction.

Increased physical activity was associated with improved emotional functioning. Reporting 3 h or more per day of moderate/vigorous activity had the strongest association with reduced odds of emotional functioning problems. This is consistent with large-scale epidemiological data in adults, which similarly suggests that although even small amounts of physical activity can decrease the odds of depression, greater amounts of physical activity may further reduce depression risk [29]. Further research is required to establish the optimal (or minimal) dosages and types of physical activity required to reduce mental illness in young people, along with examining how sedentary behaviour and screen time may interact with physical activity levels to impact on mental health [13].

The mechanistic pathways between physical activity and mental health in young people are proposed to be multiple and varied [30]. As an example, neurobiological hypotheses suggest that activity alters the structure and function of the brain, which in turn affects mental and emotional health [31,32]. Psychosocial hypotheses suggest that improved physical self-perceptions and increased social connectedness achieved through physical activity can promote positive mental health outcomes [33,34]. Behavioural hypotheses propose that physical activity can promote the development of additional skills such as coping and emotional self-regulation, and can promote wider lifestyle behaviours such as improved sleep and reduced time spent sedentary [30]. It is also plausible that the above mechanisms may operate in combination, leading to mental and emotional health outcomes. It is also possible that children experiencing poorer emotional health may experience additional barriers to engage in physical activity (e.g. low motivation, poor self-esteem, social anxiety) thus explaining the findings of this study [35].

It should also be noted that the relationship between physical activity and mental health existed independent of BMI; this is in common with activity-mental health associations previously observed [36]. Although obesity is an established risk factor for depression in adults, the relationship between the two is bi-directional [37]. In young people, the link between obesity and poor mental health may be partly due to certain adverse health behaviours (such as poor diet and physical inactivity) acting as joint risk factors for both [38]. The independent relationships between physical activity and mental health observed in this study add to the increasing body of evidence which suggests that both obesity and mental health interventions in young adults should place greater emphasis on successful modification of health behaviours. Further, it is recommended that measuring the parallel changes in mental health status, rather than focusing only on changes in overweight/obesity alone [39].

5. Strengths and limitations

This study was strengthened by the use of trained dietitians in the collection of diet related information, however these variables remain limited by potential biases associated with self-report. Further, we aimed to assess individual dietary behaviours, as opposed to overall dietary patterns. The nutritional psychiatry field promotes the use of measuring overall dietary patterns as opposed to single food items to capture an individual's overall energy and nutrient intake [40]. The assessment of individual food categories was deemed as appropriate in this study to act as a diet quality proxy, as commonly done in population-level health research. Based on our findings, further research will be conducted to assess overall dietary patterns and emotional functioning in this cohort. Similarly, physical activity was dependent on the extent to which young people recalled activities, and may have been affected for social-desirability and other bias associated with self-report methods. This study adopted a broader behavioural, biomedical and psychological approach which is an important advancement in the field of child health at the population level.

We do acknowledge that whilst our study incorporated multiple lifestyle behaviours, we chose to focus primarily on activity and diet behaviours and excluded sleep which has been increasingly shown to have critical mental and emotional health implications for young people [41]. We also acknowledge the potential for clustering of health behaviours, although additional analyses which included lifestyle variables in a single model demonstrated the same findings as separate models

https://doi.org/10.1016/j.eurpsy.2019.07.002 Published online by Cambridge University Press

(Supplementary Table 1), which suggested unique relationships with mental health. The participating sample was recruited to reflect the wider Greek population and this strengthened the applicability of the findings. We do, however, acknowledge the limitations in adopting a school-level socio-economic indicator which may have limited the accuracy to which socioeconomic disadvantage and advantage was captured.

The COOPS/WONCA Charts have previously shown good psychometric reliability in relation to detecting symptoms suggesting probable depression. This self-report measure was a limitation of this study however, which would be strengthened with the use of gold-standard interview methods for clinical diagnosis. Self-report methods also limited the dietary and physical activity measures in this study, although widely used in population-level epidemiological research. Further, BMI has been contested as a measure of overweight/obesity due to its potential for large variation in estimates and failure to capture the body composition and location of adiposity [42]. This study would have been strengthened with the use of more accurate measures such a DEXA scans, or with the inclusion of additional body composition estimates such as waist circumference [43]. We acknowledge that the unique social, economic, cultural, environmental and other characteristics of Greece at the time of financial crisis may have had subsequent implications for the physical and emotional health of children [44–46]. Whilst the specific mechanisms of such implications are outside the scope of this research we do acknowledge that the external validity of our findings may have been affected by the wider economic and socio-cultural changes occurring in Greece during this time period.

6. Conclusions

This study provides evidence from a previously under-studied child population, for the relationships between lifestyle behaviours, and physical and mental and emotional health. The rationale for investigating the potential to leverage on lifestyle behaviours, and associated existing intervention trials (i.e childhood obesity prevention, physical activity interventions), is strengthened by these findings. Future research should aim to investigate the identified relationships prospectively into adolescence and adulthood, and consider the implications of overall dietary patterns and objectively measured physical activity for mental health conditions among schoolchildren.

Healthy Growth Study Group

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Declaration of Competing Interest

None of the authors has any conflict of interest to declare.

Acknowledgments

EH is funded by an Australian Rotary Health Postdoctoral Award and the Australian National Health and Medical Research Council (1156909). JF is supported by a Blackmores Institute Fellowship. WM is supported by a Deakin University Postdoctoral Fellowship. FJ is supported by an Australian National Health and Medical Research Council Career Development Fellowship (1108125).

The Healthy Growth Study and specifically GM was co-financed by the European Union (European Social Fund – ESF) and Greek national funds through the Operational Program "Education and Lifelong Learning" of the National Strategic Reference Framework (NSRF) - Research Funding Program: Heracleitus II. Investing in knowledge society through the European Social Fund.

The authors would also like to thank the “Healthy Growth Study” group for the valuable contribution to the completion of the study.

Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.eurpsy.2019.07.002.

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https://doi.org/10.1016/j.eurpsy.2019.07.002 Published online by Cambridge University Press