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Sleep problems in adolescence and overweight/obesity in young adults: is there a causal link?

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ABSTRACT

Objective: This study aims to explore if there is a causal association between adolescence sleep problems and overweight/obesity (Ow/Ob) in young adults.
Methods: Youth self-reports were used to explore if adolescence (mean age 13.90 years, SD ±0.32) sleep problems lead to general Ow/Ob, computed from body mass index (n = 1075), or abdominal Ow/Ob, computed from waist circumference and waist to height ratio (n = 1179), in young adults (mean age 20.65 years, SD±0.82). Directed acyclic graphs were used to identify potential confounders, modified Poisson regression with a robust error variance was used to model the associations, and inverse probability weights were used to account for loss to follow-up.
Results: At adolescence, 27.37% of the subjects reported having frequent sleep problems, and about a fifth of these subjects (22.65%) developed general Ow/Ob at young adulthood.
Unadjusted regression analysis indicates a link between adolescent sleep problems and general Ow/Ob in young adults (incidence rate ratio [IRR]: 1.34, 95% confidence interval [CI]: 1.08-2.03), and this link was robust to adjustment for potential confounders (IRR: 1.47, 95% CI: 1.07-2.02). However, no such association was seen for adolescence sleep problems, and abdominal Ow/Ob computed from waist circumference (IRR: 1.30, 95% CI: 0.91-1.87) and waist to height ratio (IRR: 1.27, 95% CI: 0.86-1.88).
Conclusion: Although there is evidence for a causal association between sleep problems and general Ow/Ob, the link between sleep problems and abdominal Ow/Ob needs more research to produce conclusive results. Nonetheless, behavioral interventions encouraging healthy sleep practice in young subjects are likely to influence future Ow/Ob outcome.

Introduction

The transition from adolescence to young adulthood is considered to be one of the fastest weight gain phases of life, as concurrent changes in growth, development, behaviors, and lifestyle often create conditions favorable to weight gain.[1] Weight gained during adolescence also tends to persist later into adulthood, with only a small percentage of obese adolescents growing out of obesity in young adulthood.[2] The high rates of obesity incidence and persistence in young subjects highlight the need for preventive measures for adolescent obesity and thus reducing its persistence into adulthood.

Many studies report that behavioral interventions aiming at traditional modifiable risk factors, for example, physical activity and diet, can help prevent weight gain. Among nontraditional risk factors, inadequate sleep is emerging to be a major risk factor for overweight and obesity (Ow/Ob). Although there is sufficient epidemiological evidence to indicate a role for sleep duration in Ow/Ob,[3] the impact of sleep problems is still relatively unexplored, especially in young subjects.

Considering that some recent studies have provided substantial evidence for growing rates of sleep problems in young subjects,[4] we decided to explore the sleep and obesity association in the context of sleep problems. Although preliminary evidence from some studies indicates a positive association between sleep problems and Ow/Ob,[5,6] there are critical gaps in the existing epidemiologic evidence that limit drawing definitive conclusions. Firstly, due to cross-sectional nature of studies, it is not possible

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to ascertain the directionality of association between sleep problems and Ow/Ob.[7,8] Many studies failed to account for the role of critical confounders and, therefore, there are conflicting results on the role of sleep problems and Ow/Ob outcome.[9–11]

Another important limitation of the existing literature on the sleep-obesity link is preferentially relying on only body mass index (BMI) for obesity assessment. BMI, although simple to calculate and interpret, has limitations in distinguishing between fat and lean mass, and it is perhaps less strongly related to visceral adipose tissue than measures of abdominal obesity.[12] Some studies suggest that BMI may be inadequate and may misclassify adiposity in some individuals.[13] Abdominal obesity, assessed through waist circumference (WC) and waist to height ratio (WHtR), is reported to be a better indicator of Ow/Ob for metabolic syndrome, diabetes, and cardiovascular outcomes than BMI.[14,15] Additionally, the WHtR is found to be a better surrogate than WC and BMI for percent body fat assessment.[16] Therefore, findings based on alternative adiposity measures that reflect the degree of central fat distribution would perhaps be more reliable for exploring the role of sleep problems in cardiovascular outcomes.

Considering the gaps in the literature, we explored evidence from a prospective cohort to see if there is a causal association between adolescent sleep problems and Ow/Ob in young adults independent of other known risk factors. The main aim of this study is to assess the causal link between adolescence sleep problems and general Ow/Ob computed from BMI in young adults. We will also evaluate whether sleep problems affect abdominal obesity computed from WC and WHtR.

Participants and methods

This study is based on the sleep problems data from the Mater-University of Queensland Study of Pregnancy (MUSP) cohort obtained from 14 and 21 years of follow-up. Data were obtained from the 7223 mothers and their offspring who participated between 1981 and 1984.[17] These mothers and their offspring have been followed up prospectively, with assessments done when the offspring were 6 months and 5, 14, and 21 years of age. Written informed consent from the mothers was obtained at all data collection phases and from the young adults at the 21-year follow-up of the study. Ethics committees at the Mater Hospital and the University of Queensland approved each phase of the study. Full details of the study participants and measurements have been previously reported.[17]

Sleep problems assessment

Sleep problems can be defined as problems with sleep initiation, maintenance, and patterns that interfere with the refreshing nature of sleep.[6] At 14 years, the offspring provided information for the prevalence of 5 types of sleep issues in the past 6 months, that is, nightmares (prevalence rate = 27.88%), sleep more than others during the day and/or night (prevalence rate = 37.39%), sleep less than others (prevalence rate = 38.71%), trouble sleeping (prevalence rate = 40.6%), and feeling overtired (prevalence rate = 60.33%). Each question was rated as often (score = 2), sometimes (score = 1), or rarely/never (score = 0). We developed a composite sleep scale using sleep items in the Child Behavior Checklist (CBCL) and Youth Self-Report (YSR). It is reported that using a composite score is reliable when the aim is to examine overall sleep functioning and external correlates of sleep.[18,19]

The criteria to categorize sleep problems from the composite sleep problem score were done using an approach used in a previous study based on the Diagnostic Interview for Children and Adolescents criteria for sleep problem assessment.[20] If the study subject reported "often" on any of the sleep problems items or "sometimes" on all items, it was considered as "often" occurring sleep problem. A report of "sometimes" on 2 to 4 items was considered as "sometimes" occurring sleep problems. In all other cases, sleep problems were considered as "absent."

Assessment of anthropometric indices

Participant's height was measured without shoes using a portable stadiometer to the nearest centimeter, and weight was measured in light clothing with a scale accurate to 0.2 kg. Two measures of weight were taken with a 5-minute interval, and the mean of these 2 measures was used in all analyses. Adolescents' BMI (weight in kilograms divided by the square of height in meters) was calculated based on measured height and weight and was categorized as normal, overweight, or obese according to standard definitions derived from international surveys by Cole et al.[21] For young adults, BMI was categorized into normal (<25 kg/m^2), overweight (25-29 kg/m^2), and obese (≥30 kg/m^2) using the World Health Organization classification of BMI cut-offs.[22]

WC was used as one of the measures to assess assessing abdominal Ow/Ob. WC was measured horizontally using a tape (provided by Sullivans Haberdashery & Craft Wholesalers, Australia) roughly in line with the participant's navel or belly button, directly against the skin without compressing the skin. The average of the 2 measures was taken. WC was categorized as follows: for males: <94 cm as normal, 94-<102 cm as overweight, and ≥102 cm as obese; and for females: <80 cm as normal, 80-<88 cm as overweight, and ≥88 cm as obese.[23] However, the main limitation of WC is the inability to differentiate the cardiovascular risk level of people with different heights.[24] It was also seen that the predictive power of WC for incident hypertension improved when WC was corrected with height or hip circumference.[25]

A more recently proposed measure, WHtR, provides a more accurate reflection of body fat distribution.[26] Some studies indicate WHtR to be superior to BMI, WC, and waist to hip ratio because WHtR will change only when there is a change in the waist because height remains constant in adults.[27] We used WHtR as another measure of abdominal obesity. WHtR was calculated as the ratio of waist circumference to height. WHtR was categorized as follows: for males: <0.52 as normal, 0.53-<0.62 as overweight, and ≥0.63 as obese; and for females: <0.48 as normal, 0.49-<0.57 as overweight, and ≥0.58 as obese.[28]

Confounding factors

Covariates were selected for inclusion in the models using a directed acyclic graph (DAG), which is a method for selecting variables on which it is necessary to condition to control for confounding in the estimation of causal effects.[29] DAG models were created, and the minimum confounder set was selected using the DAGitty platform.[30]

In the creation of the DAG, relationships between each of the variables were assigned based on a priori knowledge considering that all confounding variable must affect the exposure and outcome variables, and should not be on the causal pathway. All potential confounders that have been identified, examined, and discussed in the literature were included in the DAG.[31,32] These variables are detailed in Table S1.

Statistical and epidemiological analysis

Descriptive statistics were used to present young adults' BMI, WC, and WHtR by adolescence sleep problems and lifestyle variables. Categorical variables were examined using the χ^2 test. An inverse probability weighted modified Poisson regression with a robust error variance was fitted to the data[33] using a log-link function and a binary response outcome variable to model the association between adolescence sleep problems and Ow/Ob in young adults. To increase the

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