



Full length article

## Sleep quality and duration is related with diet and obesity in young adolescent living in Sicily, Southern Italy



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### ABSTRACT

The aim of this study was to evaluate the association between sleeping habits, Mediterranean diet pattern, and weight status in an adolescent population. The sample consisted of 1586 individuals aged 11–14 years attending 15 secondary schools of Sicily, Southern Italy. School were randomly selected and the data collected during two school years. Anthropometric data was collected and body composition was assessed by bioelectrical impedance analysis. Demographic information, sleep duration, pediatric daytime sleepiness questionnaire (PDSS), physical activity and dietary habits (including adherence to the Mediterranean Diet using the KIDMED score) were further collected. The mean age was  $12 \pm 0.7$  and about 24% were overweight and obese. An inverse correlation between total sleep time and body mass index ( $\beta = -0.829$ ,  $P = 0.021$ ), fat mass ( $\beta = -0.526$ ,  $P = 0.025$ ), and waist circumference ( $\beta = -0.426$ ,  $P = 0.045$ ) was found. Similar results were found for weekdays sleep time, while an inverse relationship was found with PDSS score. Adherence to Mediterranean Diet was higher in under/normal weight adolescent with a significant linear association between the KIDMED score and the PDSS, weekdays sleep time and total sleep time. Sleep duration was also associated positively with fruits and vegetable intake and negatively with sweet and snack consumption and eating outside habits. Short sleep duration and poor sleep were associated with an increase in BMI and fat mass as well as to unhealthy eating behaviors. These findings suggest that sleep patterns could be a potential target for obesity prevention programs in young adolescence.

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### 1. Introduction

Prevalence of obesity has reached epidemic proportions across all gender, age and ethnic groups. However, overweight and obesity in children is growing alarmingly. From 1990 to 2010 the global prevalence of childhood overweight and obesity increased from 4.2% to 6.7% and is expected to reach 9.1% in 2020 [1]. Overweight and obese children are more likely to be obese adults, with many repercussions on health including cardiovascular disease, metabolic syndrome and cancer. Genetic factors, dietary behaviors, and physical activity are the main factors influencing overweight and obesity in young adolescent. However, other

factors related with modernization of life have been related to obesity and need to be better addressed [2].

Meta-analysis and systematic reviews have provided evidence that sleep patterns, sleep duration, and sleep quality are associated with overweight and obesity. Shorter sleepers had higher risk to be overweight/obese compared to longer ones, with a stronger association in boys than in girls [3–5]. Despite adolescents need about 9 to 10 h of sleep [6], the National Sleep Foundation and a recent meta-analysis, reported that teens tend to have irregular sleep patterns across the week and only the 20% had an optimal sleep duration [7,8]. Short sleep duration may affect food intake, appetite, satiety and energy balance through the modification of hormonal responses [9,10]. Moreover, alterations in sleep patterns and sleep efficiency is often associated with unhealthy habits and lifestyle modifications, such as lower physical activities, consumption of high calories foods and beverages [11,12]. The aim of this study was to evaluate the association between sleeping habits, Mediterranean Diet pattern, and weight status using bioelectrical

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impedance analysis in an adolescent population.

## 2. Methods

### 2.1. Design, setting, participants

The sample was collected during two scholastic years (period October–May of 2012–13 and 2013–14) involving students 11–14 years old attending 15 secondary schools of Sicily, Southern Italy. Schools were randomly selected after stratification based on the socio-economic level of the ten districts of the municipality of Catania to obtain a diverse range of socio-economic status (SES) among the participants. Adolescents attending last year were invited to participate ( $n=1766$ ) and 1643 (93%) provided informed consent from parents and oral consent themselves prior to filling out the questionnaire. A final number of 1586 was included in the analysis (57 subjects were excluded due to incomplete or inconsistent data from questionnaires). Participation was not compulsory and anonymity was preserved. The study was approved by the ethics committee of the University of Catania and the Department of School Policies of Catania.

### 2.2. Data collection

The questionnaire was administered during school hours, between 10 am and noon, in the classroom in presence of a teacher and researchers. There was no time restriction to complete the questionnaire. The clinical visit to registered the anthropometric measurements was performed after the questionnaire, in a separate room. Data collection was performed by three trained medical doctors and a member of the Department of the School Policies, following a specific protocol to ensure that the same conditions were met for all participants.

Demographic information, such as the adolescents' age, their parent's education level and job were collected in the first part of the questionnaire. Educational level was categorized as follow: secondary or lower, high school, and university. Occupational level was categorized as follow: unemployed and unskilled professions (i.e., manual workers), partially skilled professions (i.e., professors, nurses, etc.), skilled professions and white collars (i.e., medical doctors, lawyers, managers, etc.). Physical activity status was evaluated by the Physical Activity Questionnaire for Adolescents (PAQ-A) [13]. The score ranged from one to five and higher scores indicate higher levels of physical activity.

Information related to daily sleep patterns were collected through six questions: What time do you usually go to bed?; what time do you usually wake up?; how many minutes did you sleep on any daytime naps?; both on weekdays and weekend day, as made in other studies [14,15]. Sleep durations (hours) were calculated as the difference between self-reported bedtime and wake time, for weekdays, weekend, nap and the total week (the sum of the weekday sleep duration multiplied by five, and of the weekend sleep duration multiplied by two, was then divided by seven). Bedtime and wake time were then categorized as follows: before 21:00, between 21:00 and 22:00, between 22:01 and 23:00 and after 23:01 for bedtime; before 7:00, between 7:00 and 7:30 and after 7:30 for wake time. Moreover, adolescents were classified into one of four categories based on median splits (age and gender adjusted) of their bedtime and wake up time: EE: early bed–early rise (2210 h, 0700 h, sleep duration 8.5 h); EL: early bed–late rise (2215 h, 0730 h, sleep duration 9.15 h); LE: late bed–early rise (2245 h, 0710 h, sleep duration 8.3 h); LL: late bed–late rise (2259 h, 0755 h, sleep duration 8.5 h) [16].

To assess sleepiness, the Pediatric Daytime Sleepiness Scale (PDSS) [14], an 8-item instrument based on a Likert-scale ratings

(never=0; seldom=1; sometimes=2; frequently=3; always=4) was used. Total scores could range from 0 to 32, with higher scores indicating higher levels of sleepiness.

Finally the last part of the questionnaire focused on the dietary assessment based on a revised version of other food frequency questionnaires (FFQs) developed for Italian adolescents [17,18]. Data from that questionnaire were used to calculate the KIDMED score (Mediterranean Diet Quality Index for children and adolescent) [19] used to evaluate the different adherence to the Mediterranean diet by measuring the consumption of 16 components. Total KIDMED scores were classified as follows: 0–3 reflected a poor adherence to the Mediterranean diet; 4–7 described average adherence; and 8–12 described a good adherence.

### 2.3. Body composition assessment

Determination of body impedance was obtained using the foot to foot devices TANITA BC-420 MA (Tanita, Tokyo, Japan), with a 50 kHz frequency; According to manufacturer's instructions, skin-to skin contact was avoided in all measurements. To compute Total Body Water (TBW), the equation proposed by Bray et al. [20] was used instead the manufacturers' one. Then, a hydration fraction of 0.732 ml/g was used to compute TBW in Free Fat Mass (FFM).

Body weight (BW, Kg), body height (HT, cm) and waist circumference (WC, cm) were measured to the nearest 100 g and 0.5 cm respectively. BMI was computed as weight in kilograms divided by the square of height in meters, and international age- and gender-specific cut-off points for children according to the International Obesity Task Force were used to define their weight status in terms of underweight, overweight and obesity [21].

### 2.4. Statistical analysis

Continuous variables are presented as means and standard deviations (SDs), categorical variables are presented as absolute frequencies and percentages. Normality of variables' distribution was tested by Kolmogorov-Smirnov test. Differences between categorical variables were tested by Chi-square test. Respectively, Kruskal-Wallis test and one-way ANOVA (with Bonferroni correction) were used for multiple comparisons. The associations among the dependent variables BMI, fat mass (FM), free FM (FFM), waist circumference (WC) and selected weight-related food groups and the independent variable sleep-wake behavior and PDSS were examined using multivariate linear regression models. SPSS version 20.0 (IMB SPSS Inc) was used for all statistical evaluations.

## 3. Results

The mean age of the adolescents was  $12.0 \pm 0.7$ . Nearly 27% of participants were overweight and 24.5% were obese. Boys had a large proportion of overweight and obesity compared with girls ( $p < 0.001$ ). No other gender difference was found for the variables of interest. Moreover, adolescent who have parents with a higher education or a skilled profession were more likely to be under/normal weight. Physical activity was found to be lower in overweight and obese adolescent, while almost a half of the under/normal weight subject had a medium physical activities level. Only 84 adolescents (6%) had a good adherence to the Mediterranean Diet, with under/normal weight subject showing, on average, a greater adherence. The demographic characteristics of the 1586 adolescents (870 boys and 716 girls) distributed by BMI classification are showed in Table 1.

Table 2 presents the sleep habits of the sample according to

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