The relation between Internet use and overweight among adolescents: a longitudinal study in Switzerland

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Conflict of Interest

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Abstract

Objective. This longitudinal study aimed to investigate the characteristics and predictive risk factors of overweight among adolescents. The hypothesis was that baseline overweight predicted most overweight over time compared to other factors, especially excessive Internet use.

Subjects. A sample of 621 youths were followed from age 14 (T0 Spring 2012) to age 16 (T1 Spring 2014) in Switzerland. Participants were divided into two groups according to their weight at the final assessment: overweight and non-overweight. At T0, participants reported demographic, health, substance use and Internet use data. A logistic regression was performed to assess the explanatory variables of overweight at T1. Data are presented as adjusted odds ratios (aOR) with 95% confidence interval.

Results. The 2 year-evolution showed a net BMI increase of 4.8%. Overweight adolescents were significantly more likely to be male, to live in an urban area, to be on a diet and to report using the Internet more than 2 hours per day on weekends at T0. However, with the addition of baseline overweight, only the excessive use of Internet on weekends remained as an explanatory variable. An adolescent who was already overweight at T0 had a more than 20-fold risk (aOR 21.04) of being overweight two years later. Moreover, among adolescents becoming overweight between T0 and T1, Internet use did not show any significant effect.

Conclusion. The risk of being overweight is mostly influenced by weight status at baseline compared to excessive Internet use. Thus, our results do not confirm the negative effect of Internet on healthier activities. Internet use could at most reinforce an already existing risk of being overweight.

Key words. Internet use; overweight; obesity; adolescence; sedentary behaviour

Introduction

Overweight and obesity are major public health concerns for children and adolescents, in particular because of the possible health consequences such as diabetes, cardiovascular diseases and metabolic complications which could appear in adulthood (1-3). Besides physical health problems, overweight could also lead to psychological and emotional troubles such a poor self-esteem, depression or isolation (4, 5).

Many prevention programs and policies have been implemented to control this problem, such as the promotion of regular physical activity and balanced diet (1). Conducted from 2010 to 2013 among preschool to 9th grade pupils from mandatory schools in Switzerland, a study showed that 17% of children and adolescents were overweight. Analyzed separately, adolescents followed a higher trend with 20.5% of them considered as overweight at the mean age of 14.8 years compared to 12.3% of basic level pupils (mean age 5.7) and 18.2% of middle level pupils (mean age 10.2) (6) .

This concern is very often associated with sedentariness such as screen-time activities. This kind of occupations could decrease physical activity and cause disturbances in sleep and meals (7-9), which could affect the health and weight of adolescents. Indeed, most studies have mainly reported a positive association between screen-time activities and body mass index (BMI) in adolescence (7, 8, 10-13). Displacement theory has been used to explain that Internet use, or screen-time activities in general, takes the place of other activities (14). Indeed, this theory postulates that time spent in front of a screen is negatively associated with time spent in healthier occupations. The more adolescents would use the Internet, the less they would have time and inclination to do their homework, sport and physical activity. Nevertheless, most of the studies were cross-sectional and, consequently, the direction of the association could not be plainly determined. Furthermore, several studies showed that a reverse association between physical activity and overweight could be the cause of Internet and screen use, not its consequence (15-18). Indeed, overweight adolescents seemed to practice less physical activity because of pain or embarrassment (15). Additionally, even when a positive association between adolescents' screen-time

activities, physical inactivity and overweight was found, it did not seem to be clearly defined and remained relatively weak (7, 19). Finally, the association between Internet use or screen-time activities and higher BMI was also explained by the fact that excessive users have inappropriate and irregular dietary behaviors such as snacking (9, 20).

Overweight as well as physical and sedentary activities are complex phenomena and ask for multiple explanations (7, 12, 21). Furthermore, physical and sedentary activities seem to be two independent phenomena. Indeed, a person could be considered as sedentary even though she followed the recommendations for physical activity because these two behaviors do not seem to be mutually exclusive (12, 21). It is also known that adolescence is a period when physical activity decreases (22) and biological mechanisms could be a way to explain this trend (23). In the same idea, weight problems could also be assessed genetically with predisposition and hormones (24, 25).

The present paper aims to determine the characteristics and predictive factors of overweight/obese (from here on defined as *overweight*) adolescents. Our hypothesis is that excessive Internet use does not determine adolescents' overweight, particulary when overweight is already present. Based on the fact that overweight children or adolescents have an increased risk of being overweight in adulthood (24), we postulated that baseline overweight predicts most overweight over time compared to other factors, especially Internet use.

Methods

Data were obtained from the ado@internet.ch survey, a longitudinal study built on five bi-annual data collection waves between spring 2012 and spring 2014. For this paper, we were interested in the first (T0) and last (T1) waves. At T0, a representative sample of 35 schools in the canton of Vaud in the French-speaking part of Switzerland was obtained and 3 367 8th grade mandatory school students were invited to participate. After data cleaning, 3 064 youths were included to the first survey. At the end of the baseline

questionnaire, participants were asked whether they agreed to be contacted again for future waves of the study. Out of the 2 055 students who allowed us to contact them again, 621 completed both waves.

At baseline data were weighted according to known characteristics of the population under study (gender and school track). Longitudinal weights were then computed for wave T1 by combining the baseline weights with the probability of answering at T1 such as estimated through a logistic regression approach. The resulting weighted subsample available at T1 had a structure similar to the original baseline sample, hence similar to the one of the population under study.

Dependent variable

Overweight / obesity

Participants were requested to self-report their height and weight. BMI was calculated (weight/height squared) and participants were divided into two groups according to their weight at the time of the final assessment (T1): overweight and non-overweight (5). We defined these two categories according to international cut off points based on age and gender (26).

Independent variables

Socio-demographic data

Socio-demographic variables included gender, place of birth (Switzerland, other), place of residence (urban, rural), academic track (pre high-school, extended requirements, basic requirements), parental situation (parents together, other) and socioeconomic status. To assess the socioeconomic status, we used the ESPAD project measure asking how was their family financial situation compared to other families in Switzerland (27) and dichotomized the 7 possible answers into below average and average or better.

Health-related data

In displacement theory, physical activity seems to be displaced by Internet use (7, 10, 12-14). Indeed, adolescents would increase their sedentary activities with Internet and give up regular physical activity

proportionally. To assess physical activity, we used two measures: the number of days per week performing a physical activity for at least 60 minutes and extracurricular sports participation (yes/no).

Internet use and screen-time activities in general tend also to disturb good eating habits (9, 20). We used a food frequency questionnaire and asked them how often they ate different kinds of food such as fruits, vegetables, eggs, carbohydrates (bread, cereals), milk and dairies, meat, fish, sweets and snacks (chocolate, lemonade, chips), hamburgers and caffeinated drinks. Then, we dichotomized the different variables according to the usual guidelines for each food to know if the subject followed the guidelines or not. We added these variables to obtain a score ranging from 0 to 11 (28), with a higher score indicating a better eating habit. We also controlled for participants currently being on a diet (yes/no).

In adolescence, body image is a very sensitive subject and being overweight or obese could affect the emotional well-being (4, 5). To measure it, we used the World Health Organization Five Well-Being Index (WHO5) with poor well-being defined with a score below 13 over 25 (29).

Finally, we were interested in the mean hours of sleep on schooldays and weekends because some authors demonstrated that an excessive use of Internet and screen-time activities could decrease hours of sleep which could also affect body weight (8, 30).

Substance use data

As adolescence is a sensitive period regarding weight, substance consumption could be an escape for adolescents who feel different and under pressure. Indeed, overweight adolescents seem to be more likely to adopt risk behaviors (31). Additionally, tobacco is often considered as a way to reduce appetite and lose weight (32), thus used more frequently among overweight adolescents. Tobacco consumption was dichotomized between smokers and non-smokers (including former smokers) (33). Alcohol misuse was measured by asking how many episodes of drunkenness they had experienced in the past 30 days and dichotomized into none and at least one. We used the same process for cannabis use.

Internet use data

To assess global Internet use, we were interested in the number of connection devices, the frequency of Internet use (for the past 30 days, spending two or more hours on Internet (34) during schooldays and weekends), the score of the Internet Addiction Test (IAT) (35) and the main activity done on Internet during schooldays (leisure activity *vs.* education activity). For the question regarding the kind of devices used to connect to the Internet, there were three possible answers: computer, mobile phone and tablet, answers which were then added to obtain three categories with 0-1, 2 or 3 devices. We decided to include the complete absence of device with one device because there were only few cases (n=6). Problematic Internet use was defined by an IAT score $\geq$ 50/100 (36).

Data analysis

First we performed bivariate analyses to obtain the characteristics of the sample. Chi-squared (categorical variables) and Student's t (continuous variables) tests were used to compare the distribution of explanatory factors among the two groups (overweight and non-overweight) and to know if there was a relation between being overweight at the last wave (T1) and the independent variables at T0. All statistically significant variables at the bivariate level were entered in a logistic regression to analyze the predictor factors of being overweight. At the multivariate level, three models of logistic regression were produced. The first model did not contain baseline overweight, the second model added baseline overweight and the third model added baseline overweight and potential interactions between different outcomes to assess whether it made sense to put all these outcomes or if they measured the same phenomena.

To strengthen our results, we decided to run additional bivariate and multivariate analyses. Therefore, we removed participants who were in the overweight category both at T0 and T1 to assess what would be the explanatory variables of becoming overweight. Indeed, for the main analysis, we did not differentiate participants who became overweight from those who remained overweight. We divided this new sample

(N=552) into two groups: those who became overweight between T0 and T1 and those who did not. The same analyses as described previously were done.

A significance level of $p \leq 0.05$ was used for all analyses and all calculations were undertaken using STATA 13.0 (StataCorp, College Station, Texas).

Results

Among the 621 participants (Table 1), 13.5% of boys (n=42) and 8.8% of girls (n=27) at T0 and respectively 19.4% (n=61) and 12.4% (n=38) at T1 were overweight. Globally, the 2 year-evolution showed a net BMI increase of 4.8%. To better assess the evolution of BMI, we performed Student's t tests to compare its mean at T0 and T1. For the global sample, mean BMI was 19.6 at T0 and 21.0 at T1. For participants who were overweight during the two waves, the values were 25.3 and 27.2, and for participants who were not overweight during the two assessments, the values were 19.0 and 20.1. All these differences were significant implying an increase between T0 and T1.

For physical activity, male participants reported a mean of 3.37 days a week and this amount decreased to 2.98 days two years later. For female participants, physical activity decreased from 2.92 to 2.15 days a week. For Internet use outcomes, the connection frequency during the last 30 days showed the most important increase with 76.1% at T0 and 91.6% at T1 reporting a daily connection.

Considering statistically significant associations at the bivariate level (Table 2), adolescents identified as being overweight at T1 reported higher prevalence rates at T0 of living in an urban area, being in the lowest academic track, smoking, being on a diet, being overweight and using excessively Internet on weekends. Furthemore, overweight adolescents slept less than their peers during schooldays. Interestingly, there was no association between BMI and physical activity, sport practice or food habits. Although the association was not significant, a gender difference could be noticed with 61.4% (n=61) of overweight adolescents being male.

Regarding the multivariate analysis (Table 3), in model 1, overweight adolescents were more likely to be male, to live in an urban area, to be on a diet and to report using the Internet more than 2 hours on weekends. In model 2, with the addition of baseline overweight, only the excessive use of Internet on weekends remained as an explanatory variable. In this model, an adolescent who was already overweight at T0 had a more than 20-fold risk (adjusted odds ratio (aOR) 21.04) of being overweight two years later. This finding was verified with model 3 as even when potential interactions were included, baseline overweight remained the most important predictor (aOR 20.87).

As described in the data analysis part, we performed additional analyses to explain the fact of becoming overweight. For the bivariate analysis (Table 4), adolescents identified as becoming overweight at T1 reported higher likelihood at T0 of being male, using excessively Internet on weekends and reporting a daily connection in the last 30 days. Interestingly, at the multivariate level (data not shown), the only significant explanation of becoming overweight between T0 and T1 was being a male (aOR 3.06). However, when possible interactions between gender and Internet use were added, none of the variables included in the regression was able to explain the weight gain.

Discussion

The present results support our main hypothesis suggesting that the risk of being overweight is mostly influenced by weight status at baseline. For Internet outcomes, only the weekend use variable remained in the three models and stayed relatively weak according to baseline overweight (Table 3). Even when BMI was not included in the multivariate analysis, the other variables concerning Internet use were not significant. Furthermore, other variables which were supposed to explain overweight according to the displacement theory were not confirmed. With Student's t tests performed to assess the evolution of BMI over two years, a significant increase between T0 and T1 was observed for the global sample and the two subgroups of participants who were overweight or in those who were not during the two waves. As we found a significant difference among all these groups, we could suppose that growth and age factors

intervene. However, the difference in BMI means between T0 and T1 was slightly more important for participants who were overweight during the two years (difference 1.8) compared to the global sample (difference 1.4) and the group with participants who remained in the non-overweight range (difference 1.2). Consequently, our hypothesis can be reinforced by this difference demonstrating that overweight adolescents tend to gain more weight.

For Internet use, our results suggest that only an excessive use during weekends could explain the overall overweight. It is not so suprising to find that weekends have a strongest association with overweight than schooldays. Indeed, weekends are the main moments of spare time of the week and they allow the adolescents to choose more what they wish to do.

As mentioned before, displacement theory has been used by previous studies to explain the possible effect of Internet on weight due to a decrease of physical activity, sleep hours and balanced diet (7, 8, 10-13). Nevertheless, this explanation is not confirmed by our results. Indeed, no association was found between weight, physical activity or sport practice, sleep hours or food recommendations. Additionally, several recent studies demonstrated that fatness leads to inactivity but not the reverse (15-18). We could assume that these adolescents tended to use the Internet and isolate themselves because of their overweight, especially during weekends when they do not have to go to school. The evolution over two years shows also that even though there was a very strong increase of the connection frequency during the last 30 days, the increase in BMI and the decrease of physical activity remained moderate. Interestingly, our results also showed a decrease in the rate of problematic users which could reflect a more appropriate management of Internet use with age.

The weakness of Internet outcomes as explanatory variables of overweight or as displacement factors of other activities could be confirmed by our additional analysis regarding only participants who became overweight between T0 and T1. Indeed, even when persistent overweight adolescents were removed from the sample, Internet use could not explain the fact of becoming overweight. The frequency of Internet

connection during the last 30 days and Internet use during weekends, which demonstrated a significant positive association with becoming overweight at the bivariate level (Table 4), did not remain in the multivariate model (data not shown). Only the fact of being a boy could explain this phenomenon of becoming overweight with age. Even when possible interactions between gender and Internet use were added, none of the other variables remained significant. Gender probably interacts with other variables than those on Internet use. This gender difference was also found in the first model of our main analysis for the overall overweight group (Table 3) and is consistent with previous studies (6, 12, 13). Boys tend to have more muscle mass than girls and even if this trend is partially considered in the international cut off for the BMI of children and adolescents (26), it could explain the difference in terms of weight. Moreover, girls could be more vulnerable regarding the social pressure and the image of their own bodies which could result in a more intense concern for their weight (30).

The main strength of this study is that it is based on longitudinal data. However, some limitations need to be put forward. First, the large attrition rate. Indeed, only participants who allowed us to contact them again at the end of the baseline questionnaire could be included in the next waves. Thus, the relatively small sample size (N=621) could moderate our findings. However, data were weighted at baseline, thus we can consider them as being representative of the population under study. A second limitation could be that data were self-reported (15), particularly for height, weight and physical activity. Thirdly, we did not consider other sedentary behaviors and screen-time activities such as television or video games. However, some studies have shown that traditional media use such as conventional television viewing has decreased among adolescents and this trend seems to be linked proportionally with the increase of Internet and computer use (37, 38). Furthermore, as we can be online almost everywhere and practically on all electronic devices, Internet seems more present. Another limitation concerns the measures to assess physical activity. Indeed, we measured the number of days per week including at least 60 minutes of physical activity but not the time spend in a moderate or vigourus one, which assess the intensity of

physical activity (15). Finally, we did not assess the Tanner stage in this study but puberty could also explain a part of the metabolism and weight changes.

Conclusion

The present study could explain the difficulty in fighting overweight, inactivity, poor sleep and poor diet habits by reducing Internet use. Being overweight at baseline is the main predictor of an overall overweight compared to excessive Internet use. Thus, displacement theory is not confirmed by our results as in the end Internet does not seem to move other activities and have a strong effect on adolescents' weight. Moreover, among youths not overweight at baseline, an excessive use of the Internet is not significantly associated with a BMI increase over time. As overweight and obesity are complex phenomena, they have to be studied in connection with other variables, not only in association with one sedentary activity. Consequently, trying to reduce BMI only by decreasing Internet use could be insufficient.

In terms of prevention, this finding seems to demonstrate that if we are not able to reduce BMI during childhood, it will be very hard to reduce it during adolescence. The earliest the overweight is detected and monitored, the earliest the persistence of overweight could be managed.

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Conflict of Interest

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