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Relation between Active Transportation, Screen Time and Sleep Quality among Metabolically Healthy versus Unhealthy Congolese Obese

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Abstract

Objective: This study aims to analyze the relationship between active transportation, screen time and sleep quality among metabolically health versus unhealthy Congolese schoolboys and girls obese. **Method:** A cross-sectional study was conducted among 58 obese aged 15.36 ± 1.22 years in Brazzaville (Republic of Congo). They were divided into metabolically healthy obese (MHO, n = 29) and metabolically unhealthy obese (MUHO, n = 29). Data collection consisted of anthropometric measurements, lipids profile parameters, Pittsburgh Sleep Quality Index and the screen time measurements. The relationship was analyzed by using the logistic regression for healthy and unhealthy schoolboys and obese girls. **Results:** Compared to MUH obese subjects, MUHO obese subjects were significantly less engaged in active transportation (p = 0.03), TV and smartphone times significantly increased (p = 0.000 and p = 0.003), sleep quality significantly poor (p = 0.001). They were 1.85 (95% CI: 0.85 - 3.88) lower odds to engage in active transportation, had 1.82 (95% CI: 1.11 - 3.10) and 2.04 (95% CI: 1.11 - 3.10) higher odds of TV time respectively, had 1.87 (95% CI: 1.24 - 2.84) and 2.04 (95% CI: 1.47 - 2.85) higher odds of smartphone time respectively and have 2.35 (95% CI: 1.62 - 3.41) higher odds of poor sleep. **Conclusion:** MUHO subjects underwent high screen time and poor sleep quality. Higher TV-viewing/smartphone time and poorer sleeping quality were found to be associated with less time spent in active transportation. This bad habit on screen and sleep negatively affects the cardiometabolic parameters.

Keywords

Screen time, Sleep, Congolese Adolescents, Unhealthy Obese, At-Risk Subject

1. Introduction

By 2035, more than half of humans worldwide on track to be overweight or obese [1], because of the heterogeneity which extends obesity to metabolically healthy or metabolically unhealthy concepts [2] [3]. It is known that body mass index of 30 kg/m^2 or higher as well as excess deposits of fat in the abdominal region are used to identify individuals with obesity. However, excess weight and abdominal obesity have been shown to be associated with patterns of unfavorable metabolic. According to International Diabetes Federation (IDF), metabolic syndrome (MS) is defined by the presence of: 1) high blood pressure, defined as blood pressure ≥ 130/85 mmHg or drug treatment; 2) high fasting blood glucose level, defined as glucose ≥ 100 mg/dL or drug treatment for type 2 diabetes; 3) high serum triglycerides, defined as triglycerides ≥ 150 mg/dL or drug treatment; 4) low high density lipoprotein cholesterol (HDL-C) level, defined as HDL-C < 40 mg/dL in men and < 50 mg/dL in women or drug treatment for dyslipidemia [4]. Due to the presence or absence of metabolic syndrome, obesity can be defined as having large quantities of fat mass or body weight but exhibit a healthy metabolic profile or exhibit unhealthy metabolic profile [5] [6]. The metabolically unhealthy obesity (MUHO) is considered when ≥3 of the above criteria were met [7].

The prevalence of MUHO varies between 10.6% - 20.1% when obesity is defined by BMI and from 22.7% - 49.0% when defined by waist circumference (WC) [8]. Due to its potential impact, MUHO constitutes a concern worldwide (150 to 160 million among children and adolescents aged 5 to 17 years) and could constitute a very particular situation in Africa by 2025 (around three quarters of the obese world population will be on its ground [9]. Without widespread awareness about the risk of a low level of physical activity, poor sleep and screen media exposure, the risk of overweight and obesity will continue to increase [5] [10]-[12]. Screen time, even with a very small dose of use at night [13] or use beyond 2 hours of use per day, is more destructive compared to other sedentary activities and leads to excess weight and obesity [14]. Accordingly, poor sleep by decreasing melatonin secretions [15]-[19], reduced plasma triglycerides absorption and increases fat deposition [20] [21].

In recent years, the lifestyle of Congolese adolescents has shifted toward a more sedentary lifestyle with increased use of smartphones and other screen-based media. Over the years, we have noticed that this population does not have the will to change its bad lifestyle habits which, in its extreme cases, involve immoral behavior (for example, alcohol consumption, and transport by car to work, to school and to majority of destination rather than transport on foot). At the level of government and those responsible for health, there is no strategy to counteract the evolution of these lifestyle habits despite the fact that many studies report the importance of active transportation. The latter, which includes walking to work, to school, to any neighborhood amenity, and to any destination, with durations ranging from zero to 10-minutes, to greater than five hours, has confirmed health-promoting benefits in preventing and mitigating obesity and obesity-related commodities [22]-[24].

According to Millett *et al.* [25], it is a key strategy to increase physical activity and reduce the growing burden of non-communicable diseases. But less time spent in active transportation, combined with higher TV-viewing, smartphone time and poorer sleep quality clustered together produces higher odds with cardiometabolic disease [26]-[28]. Although not referring to MUHO directly, previous studies regarding higher screen time and poorer sleep quality with leisure physical activity, have reported the strongest associations [29]-[31]. But whether screen media exposure and sleep quality helps explain the relationship with active transportation among Congolese MHO and MUHO has not been previously investigated. Therefore, we hypothesize that less time spent in active transportation is associated to higher screen media exposure and poorer sleep among MUHO group.

2. Material and Methods

2.1. Subjects

The modified sampling method reported by Prasomsri *et al.* [32] was used for sample size calculation. Briefly, the sample size was calculated using Gpower 3.1 software, considering an alpha of 0.05, an effect size of 0.91 and a power of 0.95. The total number of participants required for the study is 58. Twenty-nine obese subjects were needed per group, in the MUHO group and MHO group, according to the sample size calculation. We conducted this cross-sectional study in one Brazzaville's private school selected for convenience. This school has the particularity of having a large space for children to be sufficiently active and of receiving students from the districts in the center and Brazzaville. Before this study, there is no information about metabolically unhealthy and healthy obese students. We used a cross-sectional design to collect the multiple data required from the selected study population at a single time point. Subjects were randomly selected based on overweight or obese status. Thereafter, they participated in an interview, physical examination, and a laboratory exam. All participants provided written informed consent, and a parent/guardian also provided informed consent for any participant less than 18 years. Procedures for data collection were approved by the National laboratory Board, and this work was accepted by the ethics committee of MARIEN NGOUABI University. Only subjects who appear for a blood sample, with a body mass index > 25 kg/m^2, a biochemical profile and WC values were included. All participants who did not appear for a blood sample as well as those without a body mass index > 25 kg/m^2, without a biochemical profile and WC values were excluded.

2.2. Anthropometric Measurements

Anthropometric measurements were carried out in a specially prepared room taking into account the recommended procedure in indoor clothing, without shoes. Weight was measured to the nearest 0.1 kg using a bioelectric impedance meter (Tanita BC 545N, Japan). Height was measured using a wooden measuring rod with an accuracy of 0.1 cm. Waist circumference (WC) was measured midway between the iliac crest and the lowest rib to the nearest 0.1 cm, as reported by Swainson *et al.* [33]. Body mass index (BMI) was calculated by dividing weight (kg) by the square of height (m^2). Obesity was defined based on age- and gender-specific BMI percentiles [34]. Cardiometabolic risk prediction was determined by calculating the waist circumference/height ratio [35]. To determine cardiac output, systolic blood pressure (PAS) and diastolic blood pressure (PAD) were measured with a cuff blood pressure monitor (HEM7121, OMRON Healthcare, China).

2.3. Fasting Blood Glucose (FBG) and Blood Lipid Biomarkers

All laboratory tests were conducted in the National Laboratory (Republic of Congo) using standard procedures. Clinical measurements and venous blood from the median cubital vein were taken in the morning after fasting. Total blood glucose was analyzed immediately after collection using a Hemocue Glucose 201 analyzer (Hemocue, Danmark). Blood glucose levels were defined as follows: 1): slightly increased: FBG ≤ 1.10 g/L 2); moderately increased: FBG 1.10 - 1.26 g/L and 3) severely increased: FBG > 1.26 g/L [36]. For lipid biomarkers, blood samples were collected and serum was extracted and frozen at −80˚C until analysis. Blood lipid biomarkers, total cholesterol (TC), high-density lipoprotein cholesterol (HDL-C), high triglycerides (TG) were measured in a certified laboratory using appropriate biochemical assays as previously described [37] [38].

2.4. Active Transportation

Information on mode of travel to and from home to school was gathered from respondents by asking, "How do they usually travel to school?" [25] [39]. There were four potential responses: public transport (bus or minibus), parent's vehicle, taxi, walking. We categorized these responses into two categories of passive transportation (bus or minibus), parent's vehicle, taxi) and active transportation (walking). We categorized respondents according to whether they were sufficient level (walking more than 30 min) or they were low level (walking less than 30 min).

2.5. Screen Time

Screen time measurement was based on the frequent use and duration of different screen devices, such as television and smartphone. They were asked to report the types of devices they use most often. Additionally, they reported their screen time between 1 to 11 AM, 12 to 5 PM, and 6 to 11 PM for seven days. The time spent on mainly television and smartphone media was summed. A total weighted mean recreational screen use was calculated as reported by Nagata *et al.* [40]: ([weekday average × 5] + [weekend average × 2])/7. Screen time was calculated as a continuous variable and categorized into four-hour increments. Excessive screen viewing time was defined as screen viewing for >2 h/day [41].

2.6. Sleep Quality Assessment

The sleep quality was assessed using Pittsburgh Sleep Quality Index (PSQI) [42]. PSQI includes 19 items summarized into seven components: 1) subjective sleep quality, 2) sleep latency, 3) sleep duration, 4) habitual sleep efficiency, 5) sleep disturbances, 6) sleeping medications, and 7) daytime dysfunction. The score of each component ranges from 0 to 3 and the total PSQI score is calculated by summation of the scores of the seven components. This total PSQI score ranges from 0 to 21 and a score of more than five was considered to identify the subjects with poor sleep quality [43].

2.7. Statistical Analysis

All statistical data were processed using SPSS version 25 software (SPSS Inc., Chicago, IL, United States). The Shapiro-Wilk test was used to determine the normality distribution. Because data showed non parametric characteristics, Mann-Whitney U test and chi-square test were used. The association of active transportation (dependent variable) with the screen time and sleep quality levels of adolescents was analyzed by logistic regression. Statistical significance was determined using a p-value < 0.05.

3. Results

Table 1. Demographic and cardiometabolic characteristics of metabolically healthy (MHO) and metabolically unhealthy obese (MUHO) phenotypes obese subjects.

	Groups		p-value
	MHO (n = 29, mean rank)	MUHO (n = 29, mean rank)	
Age (year)	31.31	27.69	0.393
Body mass (kg)	28.53	30.47	0.662
Height (m)	24.76	34.24	0.032
Body mass index (kg/m²)	28.55	30.45	0.668
Body fat (%)	23.79	35.21	0.010
Waist circumference (cm)	28.36	30.64	0.607
Hip circumference (cm)	27.28	31.72	0.313
Heart Rate rest (bpm)	24.31	34.69	0.016
Systolic blood pressure (mmHg)	18.21	40.79	**0.000**
Diastolic blood pressure (mmHg)	15.72	43.28	**0.000**
Fasting blood glucose (mg/dL)	31.22	27.78	0.429
Triglyceride (mg/dL)	27.74	31.26	0.420
HDL cholesterol levels (mg/dL)	40.71	18.29	**0.000**

Note: MHO: metabolically healthy obese; MUHO: metabolically unhealthy obese; HDL: high density lipoprotein.

Table 1 shows that adolescents with MHO were older and had lower mean BMI, Body fat, Waist circumference and hip circumference than those with MUHO. Significant differences were identified with respect to SBP, DBP and HDL cholesterol levels. By definition, individuals with a MHO phenotype had lower fasting blood glucose, triglycerides, systolic blood pressure, diastolic blood pressure and higher HDL-C. Those who were classified as MUHO were likely to be younger and had significant lower HDL-C and significant higher proportion of systolic and diastolic blood pressure.

Table 2. Comparison of active transportation, screen time and sleep quality among MHO and MUHO phenotypes adolescents.

	Groups		p-value
	MHO (n = 29, n (%))	MUHO (n = 29, n (%))	
Active transportation n (%)			
Yes	13 (68.4)	6 (31.6)	0.051
No	16 (41.0)	23 (59.0)	
Most used medias			
TV (heures/day)			
≤1 h/day	4 (100.0)	0 (0.0)	**0.000**
2 - 3 h/day	9 (100.0)	0 (0.0)	
4+ h/day	16 (37.2)	27 (62.8)	
Smartphone (heures/day)			
≤1 h/day	4 (100.0)	0 (0.0)	**0.003**
2 - 3 h/day	5 (100.0)	0 (0.0)	
4+ h/day	12 (35.3)	22 (64.7)	
Meeting recommendations n (%)	4 (100.0)	0 (0.0)	0.013
Sleep quality based on PSQI			
Good sleep n (%)	13 (86.7)	2 (13.3)	**0.001**
Poor sleep n (%)	16 (37.2)	27 (62.8)	
PSQI	18.05	40.95	**0.000**

**n* (%). **≤1 hrs screen time per day as recommended for children and adolescents [41].

As shown in Table 2, there were some differences in the MHO and MUHO phenotypes adolescents. Compared to MUHO, those with the MHO phenotype significantly spent time in active transportation. They have significantly lower TV and smartphone time respectively (p = 0.000 and p = 0.003). They have met recommendations for screen time (p = 0.013) and have significant proportion of good sleep (p = 0.000).

In logistic regression analyses, as shown in Table 3, less active transportation significantly increased TV, smartphone times and worsen sleep quality. These variables were significantly associated with less active transportation in the MUHO phenotype.

Table 3. Associations between active transportation with screen time and sleep quality among MUHO phenotypes.

	Usually walking, yes		Usually walking, no	
	OR (95 %CI)	p-value	OR (95 %CI)	p-value
Screen time				
Television				
≤1 h/day	Ref.		Ref.	
2 - 3 h/day	1.38 (0.96 - 2.00)	0.087	1.82 (0.85 - 3.88)	**0.05**
4+ h/day	1.42 (0.98 - 2.08)	0.069	2.04 (0.65 - 6.43)	**0.001**
Smartphone				
≤1 h/day	Ref.		Ref.	
2 - 3 h/day	1.41 (0.98 - 2.06)	0.069	1.87 (1.24 - 2.84)	**0.003**
4+ h/day	1.19 (0.62 - 2.28)	0.583	2.04 (1.47 - 2.85)	**0.001**
Sleep quality				
Good sleep n (%)	Ref.		Ref.	
Poor sleep n (%)	1.75 (1.01 - 2.12)	**0.009**	2.35 (1.62 - 3.41)	**0.000**

4. Discussion

The present study was conducted to analyze the relationship between active transportation with media exposure and sleep quality among Congolese MHO and MUHO phenotypes. Our findings show that: i) MHO phenotype spent more time per day in active transportation, spent less time per day in screen media (TV viewing and smartphone use) and presented a better quality of sleep compared with MUHO phenotype; ii) higher TV viewing, smartphone use and worsen sleep quality were associated with low level of active transportation in MUHO phenotype.

To our knowledge, no universal consensus has been reached regarding the classification of obese subjects according to cardiometabolic risk factors. While some studies have defined the MHO and MUHO phenotypes based on zero cardiometabolic risk factors, the present study and others have defined them using up to ≥3 cardiometabolic risk factors [7] [44] [45]. Otherwise, by observing the link between obesity and metabolic diseases, it is well documented that Obesity is an important risk factor for decreased HDL-C, which predisposes to cardiovascular diseases [46]. In the present study, we observed that apart from obese MUHO, cardiometabolic risks are lower in obese MHO phenotype. Indeed, MHO obese subjects had significantly greater level of HDL-C. Along with this significantly higher HDL-C level, they spent more time per day in active transportation. Therefore, it could be argued that active transportation to and from school to home during school time have a significant impact on high-density lipoproteins and triglycerides among MHO phenotype [47]. It seems that when the active transport carried out is sufficiently long and intense, cardiometabolic health improves best. Moreover, substituting 10 to 30 mins/day of sedentary time with equal amounts of active transportation improved in overall physical and cardiometabolic health [22] [48]. It undoubtedly acts by significantly reducing waist circumference and systolic and diastolic blood pressure [49].

In this study, self-report questionnaires were used for the assessment of both screen media exposure time and sleep quality. Data suggests that MUHO group spends more time in TV-viewing and smartphone use and had poor sleep quality compared to MHO group. Our findings are consistent with those of previous research that suggests prolonged TV-viewing, smartphone use exposure, poor sleep quality, low level physical activity and their components at later stages of life, may thus contribute to the development of Metabolic syndrome [13] [18] [29] [30] [50] [51]. To achieve such results, it seems that the MUHO group not meeting some health guidelines recommendations of 60 min of moderate to vigorous physical activity (MVPA) per day, no more than 2 h of screen time per day, and age-specific sleep duration for children and adolescents [52]. Secondly, it may be explained by a media-rich bedroom culture in which children and adolescents have their own smartphone, Internet, game console and computer to which they are exposed to the contents of these devices before sleeping.

Based on these research results, there is association between no meeting the screen media exposure and sleep quality guideline with active transportation among MUHO group. However, this conclusion appears to be controversial, given that a study by Camhi *et al.* [48] put forward different arguments. These authors provide some evidence that physical activity, but not sedentary behavior, is associated with cardiometabolic phenotypes among adults. Unlike this study, our findings are consistent with those of previous research in obese people in general that suggests there is an association between shorter sleep duration and overweight and longer screen time and overweight [29] [31].

Overall, it can be stated that any watching television and/or using smartphones as well as poor sleep quality that MUHO group spends in a day, whether they spent less time in active transportation, increases their risk of having a cardiometabolic risk profile. Consistent with previous studies, all these three predictors of metabolic syndrome are interdependent. For example, Cassidy *et al.* [53] observed that all their respondents suffering from cardiometabolic diseases reported less physical activity, more television viewing and poorer sleep habits. Kolovos *et al.* also observed that participants with comorbid type 2 diabetes and cardiovascular disease reported poor sleep duration, high TV time, and low physical activity clustered together [54]. Given the interdependent and complex links between all these three parameters, we can deduce that apart from the fact that each influences the metabolic syndrome [26]-[28], the clustering of high TV or smartphone time, poor sleep quality and spent less time in active transportation produces higher odds with cardiometabolic disease. Börnhorst *et al.* [26] states that having a media device in child's bedroom increased the odds for abdominal obesity and metabolic syndrome. Likewise, Barstad *et al.* [27] revealed that having higher screen-time increased the systolic BP and triglycerides, while lower HDL-c levels. Okubo *et al.* [28] showed that poor sleep quality (difficulties in initiating and maintaining sleep) by activating Hypothalamic-pituitary-adrenal axis (HPA), enhanced stress hormone secretion such as cortisol and catecholamine. Finally, these excess secretions lead to increased risk of metabolic syndrome.

Our results show that in the MUHO group in which participants spent less time in active transport, the odds ratio of TV-viewing, smartphone use and poor sleep quality were high. In line with our findings Cassidy *et al.* [53] have reported that even in cases where the clustering of negative lifestyle factors is not significant prevalent, metabolic syndrome disruption does occur in some individuals, for whom the risk for various health conditions may be increased. The current study provides a robust assessment of association of active transportation with TV-viewing, smartphone and sleep quality. It makes a unique contribution to the current literature in Republic of the Congo context, and provides practical implications, especially when metabolic syndrome with higher TV-viewing and smartphone use as well as poor sleeps quality increasing exponentially. The relationships between low level of active transportation and TV-viewing/smartphone use as well as sleep quality found in the current study implies that Congolese MUHO adolescents should regulate their amount of TV-viewing, smartphone usage and sleep quality in efforts to increasing active transportation and maintaining metabolic health.

Despite interesting findings, the current study has some limitations that must be highlighted. First, the cross-sectional design of this study limits our ability to make causal interpretations of the data with respect to being considered MUHO. Second, because of the design of the study, very few Congolese adolescents had this measure performed in the current study. Third, we did not collect information regarding the Objective tools for sleep assessment. Despite these limitations, our study is strengthened first by the use of many cardiometabolic risk factors to define MUHO, which allows us to capture a broader aspect of health.

3.2. Conclusion

Our results suggest that metabolically unhealthy obese group was more exposure to television, smartphone, poor sleep quality, and spent less time on active transportation than their metabolically healthy obese counterparts. Higher TV-viewing/smartphone time and poorer sleeping quality were found to be associated with less time spent in active transportation. However, these associations were not consistent across all metabolically obesity levels. Our findings add to the literature by showing that this association is stronger in metabolically unhealthy obese group compared with metabolically healthy obese group. Given the increasing screen media exposure, it is important to encourage active transportation in metabolically unhealthy obese, which may ameliorate some of the effects of extended screen time. Future research is needed to confirm the findings and to test interventions that encourage reduced screen time and increased active transportation among obese adolescents.

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Ethical Approval and Informed Consent

The study designs were approved by Institutional Ethics Committee of High institute of physical education and sport, Marien Ngouabi University, Brazzaville, Republic of Congo. An informed assent form was obtained from all participants.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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