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Prevalence and Risk factors associated with overweight and obesity among secondary Schools adolescents in Kigali City, Rwanda

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ABSTRACT

Globally, nearly 16% of the population are adolescents, among them about 85% live in low- and middle-income countries. About 71% of death is a result of NCDs globally. Overweight and obesity among adolescents count less than 20% in Africa. This research determined the prevalence and risk factors for overweight and obesity among adolescents in secondary schools in Kigali, Rwanda. A cross-sectional descriptive design was used as a quantitative approach for data collection. A sample of 378 adolescent students were selected from a target population using a technique of systematic sampling, Questionnaire was used to collect data and was analyzed using SPSS of version 2. Binary logistic regression was used to examine the relationship between overweight and obesity and the predictor variables. A total of 378 respondents participated in the study. The individual characteristic or socio-demographic contains age, Sex, Economic category (UBUDEHE), Siblings (brothers and or sisters with the group, level of education of parents (father/Mother) qualification, Parent(s) live with, Religion and Parent(s) overweight or obesity. Moreover, the lifestyle of participant(s) contains Consumption of fruits, Order takeaway, having meals with family, Consumption of snacks, taking beverages, Transport methods, Sports practice, Time spend on TV, and Time spends on smartphones. The results of this study were the prevalence of overweight was 24.9% while the prevalence of obesity was 6.9% the combination of overweight and obesity was 31.7%. To determine the prevalence and risk factors associated with overweight and obesity in secondary schools' adolescents will assist in the development and implementation of policies that promote healthy eating and physical activity in the school environment through changes in environment, behavior, and education. School policies and programs should support the adoption of healthy diets and physical activity to prevent overweight and obesity.

Keywords: *Prevalence, Risk, factors, overweight, obesity, Schools, adolescents, Rwanda*

I. INTRODUCTION

Overweight/obesity is an abnormal and/or excessive accumulation of fat in the body (WHO, 2018). This is due to an imbalance between energy intake and expenditure. (Kabor *et al*., 2020). "Obesity and overweight are global public health problems" (WHO, 2018a). The high-risk factor for many None-communicable diseases (NCDs) is obesity, and it poses a global public health threat (World Health Organization, 2019a). In the last 30 years, the occurrence of obesity and overweight among adolescents has increased rapidly globally (World Health Organization, 2019b). In adolescents, "obesity is associated with many mental health problems such as depression, low self-esteem and increased risk of infection" (Danielsen et al., 2017; Nemiary et al., 2012; Sutaria et al., 2019). Obesity negatively impacts student academic performance and also impacts overall quality of life. It is associated with psychosocial factors, mainly weight-based teasing (Buttitta *et al*., 2014). Persistent obesity led to death as a complication of chronic disease (Franks et al., 2016).

Obesity is well recognized in developed countries but is now widespread in developing countries and affects people of all ages (Afshin et al., 2017; Fuchs et al., 2017; Mokdad et al., 2018). In the Eastern Mediterranean, the occurrence of childhood obesity increased from 4.1% in 1980 to 4.9% in 2015 (Mokdad et al., 2018). "A significant increase in obesity has been observed among adolescents in general, ranging from 15% to 45% from 2004 to 2014" (Musaiger, 2014).

In developing countries, one or more nutrient deficiencies are commonly associated with overweight and obesity, mainly among women, which is considered the double burden of malnutrition (Zeba, 2018). Existing studies report that obesity can be largely prevented through early detection and prevention and control of risk, modifiable factors could be applied as prevention methods (World Health Organization, 2019a).

There have been shown a limited progress of achieving the diet-related non-communicable disease (NCD) targets in Rwanda (Global Nutrition Report, 2020). The country shows the prevalence of overweight was 19.4% and 6.4% among adolescent girls and boys respectively in Rwanda. The prevalence of obesity was 3.6% and 0.8% among adolescent girls and boys respectively (Global Nutrition Report, 2020).

This research addressed the following specific objectives:

i. To determine the prevalence of overweight and obesity among adolescents in secondary Schools of Kigali, Rwanda.
ii. To identify risk factors of socio-demographic for overweight and obesity among adolescents in secondary Schools of Kigali, Rwanda.
iii. To identify risk factors of lifestyle for overweight and obesity among adolescents in secondary Schools of Kigali, Rwanda.

II. LITERATURE REVIEW

The level of comorbidities linked to obesity in adolescents are raised by history of overweight and obesity in the childhood (Hruby & Hu, 2015). The occurrence of type II diabetes mellitus (T2D) increased in teenagers and children significantly. Almost 50 percent of incidence of diagnosed cases of diabetes in childhood have been reported currently (Pulgaron & Delamater, 2014). Increase of diabetes of type II in young peoples and children is high because of poor availability of their treatment. The probability of raised in number of nephropathy and retinopathy seen among youth population (Baek *et al*., 2021). The cardiovascular diseases (CVD) is a result of hyperlipidemia and hypertension among overweight/obese young people (Maahs *et al*., 2014). For example, obese adolescents that ages between 5 and 17 years had not less than 70% of 1 risk factor of CVD whereas 30 percent had at least 2 RISKFACTORS of developing CVD (Choukem *et al*., 2020).

Peirson *et al*. (2015) assessed the effects of obesity prevention strategies addressed on the change in BMI Zscores and BMI among young and teenagers in the period of 12 weeks and portrayed a significant caring effect for all participants with -0.15kg/m(95%CI:0.21-0.09) of SMD. There was no significance among children aged between 6 and 12 years (Peirson *et al*., 2015). Both physical activity and diet measurements were more significant than the use of one measurement, those have effective preventive even used in short period. Oude *at al*. (2019) reviewed interventions in the control of childhood obesity and showed that behavior and lifestyle alterations play a big role in overweight young people. Many studies are desired to demonstrate the efficiency of obesity prevention and therapeutic strategies among young and adolescents (Oude Luttikhuis *et al*., 2019).

According to WHO (2012) obesity is defined as an accumulation of much or unusual fat that bring risk to health. Osayande *et al*. (2018) proved altered non-invasive ways of measuring fat, such as weight, employing calipers, underwater weight assessing and bioelectric impedance and also body mass index (BMI) figuring. The body mass index is the most common non-invasive screening method. Height and weight of an individual are used in BMI. Other techniques of estimating body fat include MRI, double X-ray absorptiometry, and air displacement plethysmography. All of these methods provide accurate and precise results (Osayande et al., 2018). These strategies provide additional data; are usually significantly more expensive and intrusive (Radianti et al., 2020).

Age and sex of children must be used for deciding their BMI (Vuong *et al*., 2016). The indications of BMI among children and teenagers aged between 5 and 19 years are presented by table 2.1 based to WHO progress reference median. Obesity can be defined as a BMI more than one standard deviation above the median World health Organization growth reference. Obesity is defined as a deviation of more than two regular deviations above the World health Organization growth reference median.

Table 1 Classification of BMI between Children aged from 5 to 19 Years old

Classification	Body Mass Index(kg/m^2)
Severe thinness	<-3>
Thinness	<-2>
Obesity	>+2 (equivalent to BMIof 30kg/m^2 at 19years
Overweight	>+1 (equivalent to BMI of 25kg/m^2 at 19years

From: (WHO, 2020)

Data on the causes and risk factors of overweight and obesity are available. Research on various risk factors for obesity and overweight is complete and some of them are highlighted. Based on WHO report (2021) excess consumption of food containing calories is said to be a risk factor as provoked extra accumulation of energy. Globally, taking high fat, foods rich in energy and reduced the level of physical activity contribute to obesity (WHO, 2021). Urban sprawl, social and environmental change are factors correlate to changes in physical activity habit and affect dietary menu. Some diets such as obesogenic containing fat and sugar may be a result of abnormal metabolism and increase the level of obesity (Heber, 2015).

In Sab Sahara Africa, a lower risk of obesity and overweight linked to low birth order (Gebremedhin, 2015). This linkage is due to higher possibility of first-borns are more likely to have low birth weight that can lead to low weight in infancy period and adolescence obese (Kodzi & Kravdal, 2013). The additional, the relationship through religion has been stated in study of Cameroon (Tchoubi *et al*., 2015). A lower risk of overweight and obesity in children has been associated with Christianity rather than the Muslim religion. The report from different researchers such as Tchoubi *et al*. (2015) the compliance of the religion rules has influence on the dietary routines as some types of food are prohibited and some religion prohibit physical activities for fear of injury. It has been reported that the increased prevalence of overweight and obesity in children in Ethiopia and Burkina Faso is prevalent in private schools (Alemu & Atnafu, 2014).

A study conducted on rural school children in China found that the prevalence of overweight was 34.97% and general obesity was 16.82% (Liu et al., 2018), while in India, the prevalence of overweight

was 14.3% in boys and 9.2% in girls (Goyal et al., 2010), the additional, in Tehran, a capital of Iran, it was found that among healthy adolescent girls in general, the prevalence of overweight was 24.1% and that of obesity was 6.5%, while in the southern district the prevalence of overweight was 28.9% and obesity was 7, 7% in the North District was 19.1% overweight and 5.2% obesity (Abiri et al., 2019). "A cross-sectional study conducted among primary school children aged 9 to 14 in Dhaka, Bangladesh showed that overweight 35.7% and obesity 17.9% in public schools and 38.8% overweight and 32.7% obesity among boys in private schools" (Hossain et al., 2020).

In Brazilian children and adolescents, the prevalence of overweight was between 8.8% and 22.2%, in boys between 6.2% and 21%, in girls between 6.9% and 27.6%. Regarding obesity, it ranged from 3.8% to 24%, from 2.4% to 28.9% for boys and from 1.6% to 19.4% for girls (Pelegrini et al., 2021). A study conducted among Australian children and adolescents between the ages of 5 and 17 showed that 25% were overweight and 8.25% were obese (Sanders et al., 2015). In the Netherlands, the prevalence of overweight was 13.25 in primary school children aged 4 to 12 and 19.3% in 12 to 16-year old, and that of obesity was 2.7% and 2.3%, respectively (Ten Velde et al., 2021).

In Rwanda, an estimation of 11.5% women and 2.5% men living with obesity. The level of obesity in Rwanda is low comparing to the region average of 20.7 for women and 9.2 for men. In Rwanda, the prevalence of overweight was 19.4% for adolescent girls and 6.4% among adolescent boys. Obesity was 3.6% for girls and 0.8% for boys (Global Nutrition Report, 2020). Available data are on country level, there is gap in providing data presenting how the cases are in different parties of country especially in different town of Rwanda.

The studies on factors related to overweight or obesity carried out in low- and middle-income countries were very often carried out in urban areas (Oladimeji et al., 2014; Sagna, 2014), in hospitals and in secondary schools (Mabiala-Babela et al., 2011; Tene Marceline, 2014). There is little representative national-level data on obesity in many sub-Saharan African countries (Msyamboza et al., 2013).

In Rwanda, there are few studies on the prevalence and factors correlating with overweight and obesity, and there is a gap in study concerning overweight and obesity among secondary school students as there is no study have been conducted. The life style of students in urban area of Rwanda are now modernized and this is a result of NCDs development so there is a gap in study providing frequency and possible measurements among this particular group of children.

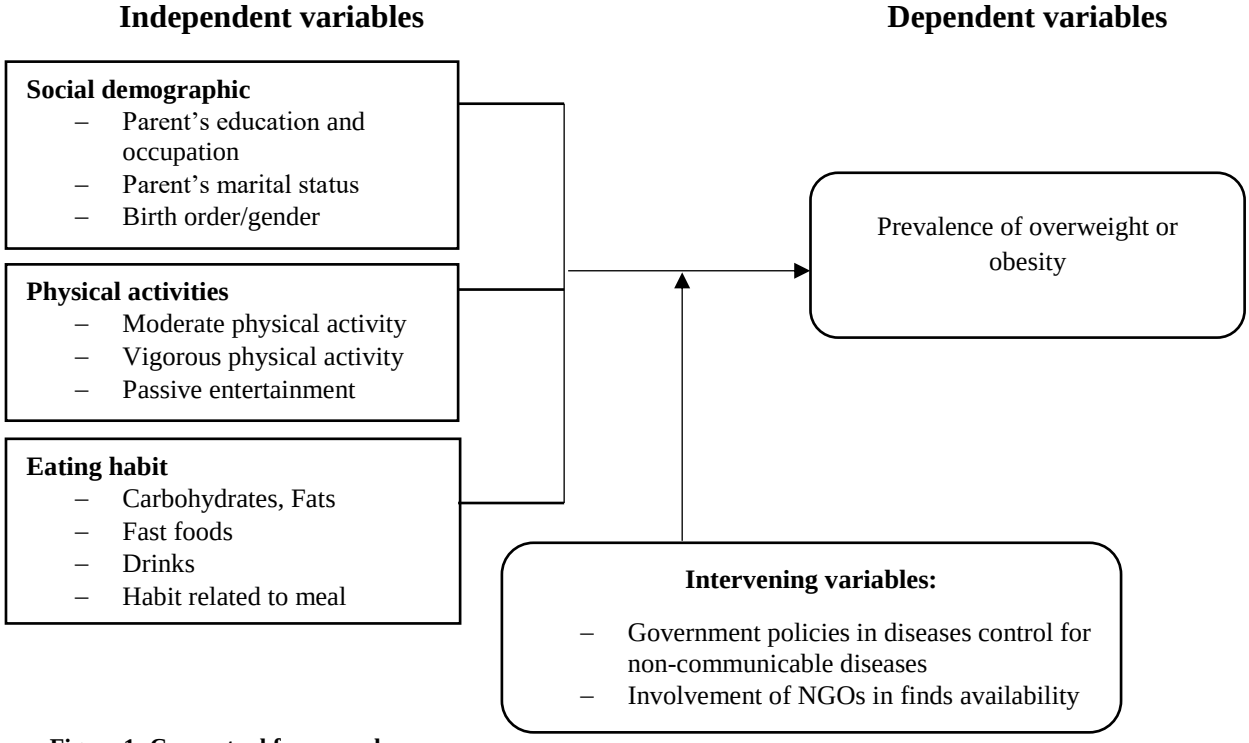

Figure 1: Conceptual framework

Source: Researcher, (2020)

Figure 1 indicates that for an adolescent to develop overweight or obesity depends on social demographic characteristics of the respondents, level of physical activities, eating habit and level of knowledge about overweight & obesity, eating habits, physical activity related to energy. This relationship is indirectly influenced by government policies.

I. MATERIALS AND METHODS

The target population consisted of 1211 students of adolescents in studying in selected secondary schools of Kigali City aged from 12 to 19 years and the sample size was 416. A cross-sectional descriptive design was use quantitative approach for data collection. A sample of 378 adolescent students were selected from a target population using technique of systematic sampling, Questionnaire was used to collect data and was analyzed using SPSS of version 21. Binary logistic regression was used to examine the relationship between overweight and obesity and the predictor variables. The chi-square test is used to assess the degree of association between variables.

II. RESULTS AND DISCUSSIONS

The prevalence of overweight and obesity among adolescents in secondary schools in Kigali city, Rwanda.

The first objective of this study was to determine the prevalence of overweight and obesity among adolescents in secondary schools**.**

The overall prevalence of overweight was presented in percentage as 94 students represented by 24.9%. The obesity was presented as 22 students represented by 6.9% and the combination of overweight and obesity was 120 students represented by 31.7% while the normal participant was 258 students represented by 68.2%.

Figure 2. The prevalence of overweight and obesity among adolescents in secondary schools

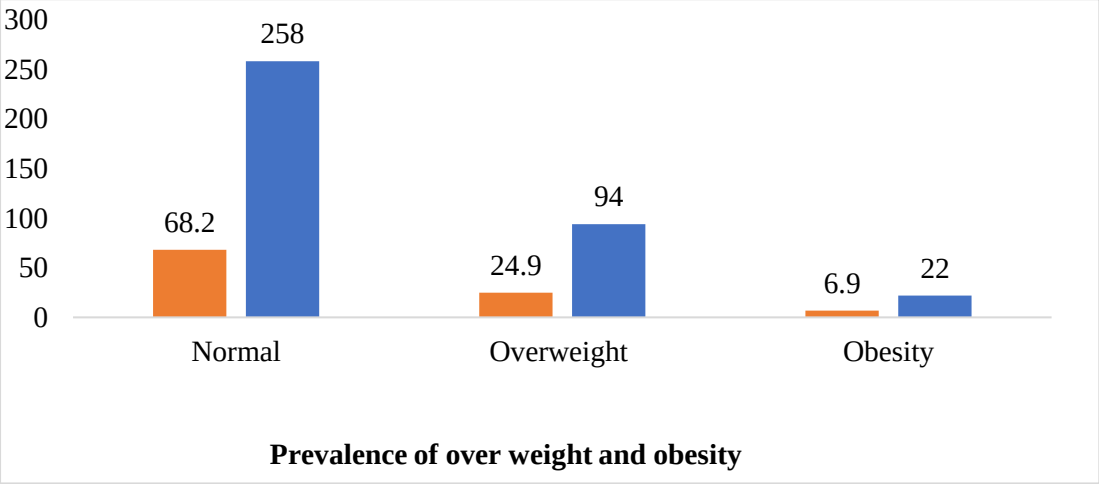

Figure 2. Prevalence of overweight and obesity

Source: Primary data, (2022)

Socio-demographic factors associated with overweight/ obesity among adolescents in secondary Schools

The second objective of this study was to assess the risk factors associated with overweight/ obesity among adolescents in secondary Schools in Kigali city, Rwanda. Bivariate and multivariate were used to establish factors associated with overweight and obesity among secondary adolescents' schools. Those risk factors are set into two (2) categories. First category is about socio-demographic factor associated with overweight/obesity among adolescents' secondary schools, the second category is about life style factor associated with overweight/obesity among adolescents' secondary schools.

The bivariate analysis of socio-demographic characteristics with overweight/ obesity among adolescents in secondary Schools in Kigali city Rwanda is presented in Table 4.4.

Table 2 Socio-demographic factors associated with overweight/ obesity among adolescents in secondary Schools

Variables	Oveweight/Obesity		OR	95% CI		P Value
	Yes, N(%)	No, N(%)		Lower	Upper	
Age-group						
12-15 years	66(31.9)	141(68.1)	1.01	0.66	1.57	0.949
16-19 years	54(31.6)	117(68.4)	Ref			
Sex						
Male	34(18.9)	146(81.1)	Ref			
Female	86(43.4)	112(56.6)	3.30	2.28	5.26	< **0.001**
Parent with Overweight/ Obesity						
No	70(25.8)	201(74.2)	Ref			
Yes	50(46.7)	57(53.3)	2.52	1.58	4.02	< **0.001**
Economic category (ubudehe)						
Class I	3(5.1)	56(94.9)	Ref			
Class II	10(14.3)	60(85.7)	3.11	0.81	11.89	**0.001**
Class III	34(31.5)	74(68.5)	8.58	2.51	29.36	< **0.001**
Class IV	73(51.8)	68(48.2)	20.04	5.99	67.04	< **0.001**
Live with parent						
Father	3(30.0)	7(70.0)	0.95	0.20	4.55	0.951
Mother	50(42.0)	69(58.0)	1.61	0.68	3.83	0.281
Both	58(26.4)	162(73.6)	0.80	0.34	1.84	0.595
None of them	9(31.0)	20(69.0)	Ref			
Parent education						
Upper education	70(33.8)	137(66.2)	1.23	0.52	1.25	0.342
Lower education	50(29.2)	121(70.8)	Ref			
Siblings group						
0 to 2	63(32.6)	130(67.4)	1.09	0.71	1.68	0.702
3 and more	57(30.8)	128(69.2)	Ref			
Religion						
Catholic	40(34.8)	75(65.2)	1.06	0.62	1.83	0.824
Muslim	50(29.9)	117(70.1)	1.25	0.75	2.07	0.392
Other	30(31.2)	66(68.8)	Ref			

Key: OR Odds Ration, CI: Confidence interval *significant at P<0.05 bolded

Source: Primary data, (2022)

The female participants were 3.23 more likely to develop overweight or obesity compared to the male participants [OR=3.23; 95%CI=2.28-5.26; p<0.001). The respondents were having Parent with Overweight/ Obesity were 2.52 more likely to develop overweight or obesity compared to the

participants were not having Parent with Overweight/ Obesity [OR=2.52; 95%CI=1.58-4.02; p<0.001). The respondents of class IV of ubudehe (economic category) were 20.039 more likely to develop overweight or obesity compared to the participants of class I [OR=20.04; 95%CI=5.99-67.04; p<0.001).

Lifestyle factors associated with overweight and obesity among adolescents in secondary Schools

The second objective of this study to identify risk factors of socio-demographic for overweight and obesity among adolescents in secondary Schools of Kigali, Rwanda. The bivariate analysis of life style characteristics with overweight/ obesity among adolescents in secondary Schools in Kigali city Rwanda is presented in Table 4.4.

Table 3 Lifestyle factors associated with overweight and obesity among adolescents in secondary Schools of Kigali, Rwanda

Variables	Overweight/Obesity		OR	95% CI		P Value
	Yes, n(%)	No, n (%)		Lower	Upper	
Consumption fruits a week						
Rare	42(87.5)	6(12.5)	38.50	15.44	96.00	< **0.001**
Few days	34(77.3)	10(22.7)	18.70	8.62	40.58	<**0.001**
Every day	44(15.4)	242(84.6)	Ref			
Order takeaway in week						
Rare	11(78.6)	3(21.4)	Ref			
1 to 2 time a week	23(37.7)	38(62.3)	9.25	2.52	33.96	**0.001**
3 and more time a week	86(28.4)	217(71.6)	1.53	0.86	2.71	0.149
Have meal with family						
Never	19(38.0)	31(62.0)	1.12	0.45	2.78	0.801
Sometimes (days)	89(30.3)	205(69.7)	0.80	0.38	1.68	0.549
Every day	12(35.3)	22(64.7)	Ref			
Consumption snacks						
Rare	14(63.6)	8(36.4)	Ref			
1 to 2 times a day	29(37.2)	49(62.8)	4.57	1.84	11.32	**0.001**
3 and more times a day	77(27.7)	201(72.3)	1.55	0.91	2.62	0.107
Take beverage juice a day						
Rare	8(5.4)	140(94.6)	Ref			
1 to 2 times a day	44(37.0)	75(63.0)	10.27	4.59	22.94	< **0.001**
3 and more times a day	68(61.3)	43(38.7)	27.67	12.33	62.11	< **0.001**
Transport method						
On feet	10(45.5)	12(54.5)	1.61	0.65	3.95	0.301
By Bus or Car	54(28.1)	138(71.9)	0.75	0.48	1.18	0.221

By motor bike or Bicycle	56(24.1)	108(65.9)	Ref			
Physical activities practice						
Never	59(53.6)	51(46.4)	6.63	3.41	12.89	< **0.001**
1-3 days	46(27.5)	121(72.5)	2.18	1.14	4.15	**0.018**
4 and above	15(14.9)	86(85.1)	Ref			
Time spend on TV						
Rare	11(12.9)	74(87.1)	Ref			
Less than 30 minutes a day	15(23.4)	49(76.6)	2.06	0.87	4.86	0.099
More than 30 minutes a day	94(41.0)	135(59.0)	4.68	2.36	9.30	**0.001**
Time spend on smart phone						
Rare	27(21.3)	100(78.7)	Ref			
Less than 30 minutes a day	14(28.6)	35(71.4)	1.48	0.69	3.14	0.305
More than 30 minutes a day	79(39.1)	123(60.9)	2.38	1.43	3.96	**0.001**

Key: OR Odds Ration, CI: Confidence interval *significant at P<0.05 bolded

Source: Primary data, (2022)

The respondents were rare consuming fruits were 38.50 more likely to develop overweight or obesity compared to the participants were every day consuming fruits [OR=38.50; 95%CI=15.44-96.00; p<0.001).

The respondents were 1 to 2 times ordered takeaway in week were 9.25 more likely to develop overweight or obesity compared to the participants were rare ordered takeaway in week [OR=9.25; 95%CI=2.52-33.98; p=0.001). The respondents were taking 1 to 2 times snacks a day were 4.57 more likely to develop overweight or obesity compared to the participants were rare taken snacks a day [OR=4.57; 95%CI=1.84-11.32; p=0.001). The respondents were 3 and more times taking beverage juice a day were 27.67 more likely to develop overweight or obesity compared to the participants were rare taken beverage juice [OR=27.67; 95%CI=12.33-62.11; p<0.001). The respondents were never do the physical activities were 6.63 more likely to develop overweight or obesity compared to the participants were doing physical activities 4 and more time a week [OR=6.63; 95%CI=3.41-12.89; p<0.001). The respondents were more than 30 minutes a day spending time on TV were 4.68 more likely to develop overweight or obesity compared to the participants were rare spending time on TV [OR=4.68; 95%CI=2.36-9.30; p=0.001). The respondents were more than 30 minutes a day spending time on smart phone were 2.38 more likely to develop overweight or obesity compared to the participants were rare spending time on TV [OR=2.38; 95%CI=1.43-3.96; p=0.001).

III. DISCUSSION

The aim of this study was to prevalence and risk factors associated with overweight and obesity among secondary schools' adolescents in Kigali city, [RWANDA]. The results showed the prevalence of overweight and obesity. Some variables of socio-demographic characteristics which high level of economic class and having parent with overweight or obesity were associated with overweight and obesity as risk factors. Many variables of life style lack of fruits consumption, taking beverage juice, lack of sport practices, spend a lot of time watching TV were risk factors of overweight and obesity.

The prevalence of overweight was 24.9% while the prevalence of obesity was 6.9% and the combination of overweight and obesity was 31.7%.

Regarding socio-demographic characteristics, economic class and parent overweight or obesity live with had statistical significance with overweight or obesity. Families with economic class IV were more likely to develop overweight/ obesity 37.3% [AOR=18.03; 95%CI=3.78-86.08; p<0.001)]. Having Parent(s) with overweight or obesity were more likely to develop overweight/ obesity 28.3% [AOR=4.00; 95%CI=1.73-9.25; p=0.001)]

Poor fruits consumption habit 12.7% [AOR=24.74; 95% CI: 6.49-94.23; *p<0.001*]. Time spend on, the more time spend on TV 60.6% [AOR=7.58; 95%CI=2.47-23.25; p<0.001] were more likely to develop overweight/ obesity. Taking more beverage juice were 16.29 associated with developing overweight and obesity 39.4% [AOR=16.29; 95%CI=5.42-48.93; *p<0.001*). And more less physical activities or sport practice the 7.031 more developing overweight and obesity 29.1% [AOR= 7.03; 95% CI: 2.34-21.11; *p= 0.001*].

IV. CONCLUSION

The purpose of this study was to determine the prevalence and risk factors associated with overweight and obesity among secondary schools' adolescents in Kigali city. The results reveal that the prevalence of overweight and obesity were 24.9% and 6.9% respectively and combination of 31.7% overweight and obesity, the risk factors associated with overweight and obesity were parent with overweight or obesity and high economic category, lack of consumption of fruits, take beverage juice, lack of sport or physical activities and spend lot of time on TV. This research is important as it implicates on implementation regarding Overweight/obesity control among adolescents. The findings intended to address recommendation and suggestions in order of taking this problem into consideration.

V. FUTURE RESEARCH

Follow up studies could be conducted in different part of country in order to provide real map of cases.

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REFERENCES

1] Abiri, B., Sarbakhsh, P., & Vafa, M. (2019). Prevalence of overweight, obesity, and associated risk factors in healthy female adolescents in Tehran, Iran. *Central Asian Journal of Global Health, 8* (1). https://doi.org/10.5195/cajgh.2019.413

2] Afshin, A., Forouzanfar, M. H., Reitsma, M. B., Sur, P., Estep, K., Lee, A., Marczak, L., Mokdad, A. H., Moradi-Lakeh, M., Naghavi, M., Salama, J. S., Vos, T., Abate, K. H., Abbafati, C., Ahmed, M. B., Al-Aly, Z., Alkerwi, A., Al-Raddadi, R., Amare, A. T., Murray, C. J. L. (2017). Health Effects of Overweight and Obesity in 195 Countries over 25 Years. *The New England Journal of Medicine, 377* (1), 13–27. https://doi.org/10.1056/NEJMoa1614362.

3] Afshin, A., Forouzanfar, M. H., Reitsma, M. B., Sur, P., Estep, K., Lee, A., Marczak, L., Mokdad, A. H., Moradi-Lakeh, M., Naghavi, M., Salama, J. S., Vos, T., Abate, K. H., Abbafati, C., Ahmed, M. B., Al-Aly, Z., Alkerwi, A., Al-Raddadi, R., Amare, A. T., Murray, C. J. L. (2017). Health Effects of Overweight and Obesity in 195 Countries over 25 Years. *The New England Journal of Medicine, 377* (1), 13–27. https://doi.org/10.1056/NEJMoa1614362.

4] Alemu, E., & Atnafu, A. (2014). Prevalence of Overweight and/or Obesity and Associated Factors among High School Adolescents in Arada Sub city, Addis Ababa, Ethiopia. *Journal of Nutrition & Food Sciences, 4* (2), 10-14. https://doi.org/10.4172/2155-9600.1000261

5] Al-Hazzaa, H. M., Abahussain, N. A., Al-Sobayel, H. I., Qahwaji, D. M., & Musaiger, A. O. (2012). Lifestyle factors associated with overweight and obesity among Saudi adolescents. *BMC Public Health, 12* (1), 1–11.

6] Buttitta, M., Iliescu, C., Rousseau, A., & Guerrien, A. (2014). Quality of life in overweight and obese children and adolescents: a literature review. *Quality of Life Research, 23* (4), 1117–1139.

7] Danielsen, Y. S., Stormark, K. M., Nordhus, I. H., Mæhle, M., Sand, L., Ekornås, B., & Pallesen, S. (2017). Factors associated with low self-esteem in children with overweight. *Obesity Facts, 5* (5), 722–733.

8] Goyal, R. K., Shah, V. N., Saboo, B. D., Phatak, S. R., Shah, N. N., Gohel, M. C., & Patel, S. S. (2010). Prevalence of overweight and obesity in Indian adolescent school going children: its relationship with socioeconomic status and associated lifestyle factors. *The Journal of the Association of Physicians of India*, *58* (1), 151-158.

9] Kaboré, S., Millogo, T., Soubeiga, J. K., Lanou, H., Bicaba, B., & Kouanda, S. (2020). Prevalence and risk factors for overweight and obesity: a cross-sectional countrywide study in Burkina Faso. *BMJ Open, 10* (11), e032953.

10] Maahs, D. M., Daniels, S. R., De Ferranti, S. D., Dichek, H. L., Flynn, J., Goldstein, B. I., Kelly, A. S., Nadeau, K. J., Martyn-Nemeth, P., Osganian, S. K., Quinn, L., Shah, A. S., Urbina, E., Maahs, D. M., Daniels, S. R., De Ferranti, S. D., Dichek, H. L., Flynn, J., Goldstein, B. I., Urbina, E. (2014). Cardiovascular disease risk factors in youth with diabetes mellitus: A scientific statement from the American heart association. *Circulation, 130* (17), 1532–1558. https://doi.org/10.1161/CIR.0000000000000094

11] Msyamboza, K. P., Kathyola, D., & Dzowela, T. (2013). Anthropometric measurements and prevalence of underweight, overweight and obesity in adult Malawians: Nationwide population based NCD STEPS survey. *Pan African Medical Journal, 15* (1), 1–11. https://doi.org/10.11604/pamj.2013.15.108.2622

12] Nemiary, D., Shim, R., Mattox, G., & Holden, K. (2012). The relationship between obesity and depression among adolescents. *Psychiatric Annals, 42* (8), 305–308.

13] Osayande, O. E., Azekhumen, G. N., & Obuzor, E. O. (2018). A comparative study of different body fat measuring instruments. *Nigerian Journal of Physiological Sciences : Official Publication of the Physiological Society of Nigeria, 33* (2), 125–128.

14] Peirson, L., Fitzpatrick-Lewis, D., Morrison, K., Ciliska, D., Kenny, M., Usman Ali, M., & Raina, P. (2015). Prevention of overweight and obesity in children and youth: a systematic review and meta-analysis. *CMAJ Open, 3* (1), E23–E33. https://doi.org/10.9778/cmajo.20140053

15] Pulgaron, E. R., & Delamater, A. M. (2014). Obesity and type 2 diabetes in children: epidemiology and treatment. *Current Diabetes Reports, 14* (8), 508. https://doi.org/10.1007/s11892-014-0508-y
16] Radianti, J., Majchrzak, T. A., Fromm, J., & Wohlgenannt, I. (2020). A systematic review of immersive virtual reality applications for higher education: Design elements, lessons learned, and research agenda. *Computers & Education, 147*, 103778. https://doi.org/https://doi.org/10.1016/j.compedu.2019.103778
17] Vuong, A. M., Braun, J. M., Sjödin, A., Webster, G. M., Yolton, K., Lanphear, B. P., & Chen, A. (2016). Prenatal Polybrominated Diphenyl Ether Exposure and Body Mass Index in Children Up To 8 Years of Age. *Environmental Health Perspectives, 124* (12), 1891–1897. https://doi.org/10.1289/EHP139
18] WHO. (2021). *Obesity and Overweight. In Springer Reference*. https://doi.org/10.1007/springerreference_223608
19] Zeba, A. N. (2018). *Transition nutritionnelle et double fardeau de la malnutrition chez des adultes de Ouagadougou au Burkina Faso (Afrique de l'Ouest*). Universite de Montreal (Canada).

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