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Original Article:

Prevalence and Associated Factors of Obesity among South African Adults: A Cross-Sectional Study

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Abstract: BACKGROUND: Obesity contributes to the burden of chronic diseases and it is a public health challenge. The rate of overweight and obesity in South Africa is dramatically on the increase and disturbingly high. This study aimed at determining the prevalence and predictors of overweight and obesity among adults in Eastern Cape Province of South Africa; which information is lacking. METHODOLOGY: This cross-sectional survey utilised the WHO STEPwise approach in collecting data on demographic and behavioural factors from 1077 adults attending the three largest out-patient clinics in the Buffalo City Metropolitan municipality, Eastern Cape. Height and weight were measured in accordance with standard procedure. Obesity and overweight were defined according to WHO criteria. We performed bivariate and multivariate (logistic regression) analyses to determine the significant predictors of obesity. RESULTS: The prevalence of overweight and obesity were 24% and 46%, respectively. The prevalence of obesity was higher among female (53.4%) compared to males (27.4%). Obesity was strongly associated with pre-diabetes (250/54.7%, RR=2, 95% CI 1.6-2.6, p=0.001), diabetes (145/59.4%, RR=2.1, 95%CI 1.6-2.9, p=0.001) and hypertension (276/56.2%, RR=2.4, 95%CI 1.9-3.1, p=0.0001). In the multivariate analysis, after adjusting for confounding factors, only age (AOR= 2.0, 95%CI= 1.3-3.0), sex (AOR= 3.8, 95%CI= 2.7-5.3), being married (AOR=2.3, 95%CI= 1.7-3.2), hypertension (AOR=2.0, 95%CI= 1.5-2.8), diabetes (AOR=1.4, 95%CI=1.0-2.0) and no cigarette smoking (AOR= 2.8, 95%CI= 1.7-4.5) were the independent and significant predictors of obesity among the participants. CONCLUSION: The prevalence of obesity was high and strongly associated with cardiovascular risk factors. Health policies targeting obesity and cardiovascular risk factors should be prioritised by the Eastern Cape and South African government in order to mitigate the burden of non-communicable diseases.
Key Words: Obesity, Diabetes, Hypertension, Metabolic syndrome, Buffalo City Metropolitan Municipality

Introduction:
Overweight and obesity occurs when there is excessive and abnormal accumulation of fat in such a manner that is detrimental to health.(1) Globally, about 1.9 billion individuals are overweight and 600 million are obese.(1,2) Overweight and obesity have become major public health concerns due to the associated morbidity and mortality.(3)
Overweight and obesity increase the likelihood of developing non-communicable disease (NCDs) and certain cancers.(4) Thus, increasing the burden of non-communicable diseases and invariably, promoting premature mortality and disability.(5) Unfortunately, no significant progress has been documented towards curtailing this rising epidemic in the past 33 years.(6)
South Africa is not exempted from the surging menace of overweight and obesity. South African women were reported to have the highest prevalence of obesity (42%) in sub-Saharan Africa.(7) Many reasons have been advanced for the increasing prevalence of overweight/obesity: adoption of westernized unhealthy diets and neglect of the traditional diets rich in fibre, and changing lifestyles resulting in physical inactivity, smoking and harmful alcohol use.(8)
Obesity prevalence may however, not decline in South Africa any time soon as many South Africans still have poor perception and knowledge on the health implications of obesity and still sees it as a sign of affluence.(9) Public health policies targeting the factors associated with

overweight/obesity at individual level and population level are required to tackle the rising burden of obesity and overweight.(10) As such, epidemiologic data on the prevalence of overweight/obesity and the associated factors will contribute significantly toward crafting an effective and appropriate public health policy targeting the at-risk population, and affected individuals in the country.

Although, studies have been conducted on the prevalence of overweight and obesity in South Africa;(11,12) however, evidence from the literature shows a paucity of data on the prevalence and predictors of overweight and obesity in the Eastern Cape; the second poorest Province in South Africa. We sought to determine the prevalence and predictors of obesity among adults in BCMM, South Africa.

Materials and Methods

Study area and design: The descriptive, cross sectional study was conducted in the three largest out-patient clinics in the rural and semi-urban communities of Buffalo District Metropolitan Municipality (BCMM); Cecilia Makiwane hospital, Nontyatyambo and Empilweni-Gompo Community Healthcare centres. These regional and primary health care facilities serve a total population of 755,200 residents in BCMM.(13)

Participants and Sample size: The appropriate sample size was estimated using the following formula:

$N = (Z1 - \alpha)\ 2 * (P\ (1 - P))/ D2$

Where Z is the confidence level, P is the expected proportion of individuals with obesity, and D is the margin of error. P was set at 0.40 and D at 0.05. The calculation was performed at the 95% confidence level. The required sample size per study site was 369 participants and a total of 1107 participants were included in the study.

All ambulatory individuals (patients and their family members) who fulfilled the inclusion criteria and attending the study settings during the period of study were recruited into the study. This study was conducted in April-May, 2016.

Eligibility criteria: Participants were included in the study if they were: 18 years and above, attending the out-patient clinics of the selected hospital and community health centres, willing to participate and had fasted in the preceding eight hours prior to recruitment into the study. Participants were excluded if they were acutely ill, psychotic, debilitated, pregnant or handicapped in any form such that obtaining anthropometric measurement would be difficult.

Data collection: Eligible participants (n=1107) were recruited in series at the settings of the study. A total of 109 participants were excluded due to incomplete data, resulting in a final sample size of 998. The participants were interviewed using the previously validated WHO STEPwise questionnaire (14) which comprised three major items; demographic and behavioural data, and measurements. Demographic variables included items on sex, age, marital status, level of education, employment status and average monthly income earning. The socioeconomic factors were measured by assessing the average monthly income, level of education and employment status. Participants were categorised as low income earners if they earned R2000 or less per month and middle income earners if they earned more than R2000. Level of education was obtained by self-reporting of the highest grade level attained in school and were categorised as having no formal education, primary (grade 1-7), secondary (grade 8-12) or tertiary (post-secondary). Participants were defined as unemployed if they reported that they were not employed in both formal and informal sectors.

The following behavioural variables were obtained by self-reporting; cigarrete smoking, alcohol use, physical activity, and fruit and vegetables consumption patterns. Participants were questioned on their servings of fruit and vegetables daily. The smoking categories include; primary smokers (smoking directly) or secondary smokers (if living with a smoker) or non-smoker. Physical activity level of participants were obtained by self-reporting and categorised based on their engagement in moderate (yes/no) or vigorous intensity (yes/no) exercise leading to an increase in heart rate and respiratory rate such as gardening.

Measurements

Anthropometry: We followed the recommendations of the International Society for the Advancement of Kinanthropometry (ISAK) in ensuring accuracy of measurements.(15) Trained research assistant performed the measurements on all the participants. The height of the participants was measured in standing position with closed feet (without shoes or headgears) using a stadiometer. The mobile part of the stadiometer was adjusted to just touch the participants' head. The perpendicular distance between the vertex of the head and the feet was recorded as the participant's height to the nearest 0.1 meter (m). The weight of the participants was measured in light clothing to the nearest 0.01kilogram (kg) in the standing position with closed feet, holding their breath in full inspiration and Frankfurt line of vision, using Soehnle Scale (Soenle-Waagen Gmbh Co., Muurhardt, Germany). The body mass index (BMI) was calculated as weight in kg divided by height in square metres (kg/m2). BMI was categorized in accordance with WHO criteria(1) as <18.5kg/m2, 18.5-24.9kg/m2, 25.5-29.9kg/m2 and >30.0kg/m2 as underweight, normal, overweight and obese, respectively

Blood Pressure: Blood pressure (systolic and diastolic) was measured in accordance with standard protocols (16) with a validated Microlife BP A100 Plus model which provided average of two readings for each participant. We ensured that the participants had rested in sitting position for at least five minutes, feet on the ground and arm supported on the table. Appropriate cuff for each participant was wrapped snuggly around the upper arm and maintained in place with Velcro on the cuff. Hypertension was defined as average of two systolic blood pressure of $\geq$ 140mmHg and diastolic of $\geq$ 90mmHg in accordance with the Eight Joint National Committee.(17)

Glucose testing: Fasting capillary blood glucose of each participant was measured with a validated ACCU-CHEK glucose monitoring apparatus in Fasting state. Participants were diagnosed of having diabetes if their fasting blood glucose exceeded 7.0 mmol/L or current medications for diabetes and they were defined as having pre-diabetes if the fasting blood glucose falls between 6.1-6.9 mmol/L.(18)

Ethical consideration: The study protocol was approved by the University of Fort Hare Research Ethics Committee and the Eastern Cape Department of Health. The management of the sub-district department of health as well as the head of the respective health facilities gave permission prior to data collection. Participants were provided with information sheet detailing the purpose and process of the study; and this was communicated verbally to ensure proper and adequate understanding of the nature and purpose of the study by participants. Each participant gave written informed consent for his/her voluntary participation in the study.

Statistical Analysis: Characteristics of study variables were expressed as mean for continuous variables. Frequencies and proportions were reported for categorical variables. The bivariate and multivariate logistic regression were used to identify the significant associated factors of obesity and their 95% confidence interval (95% CI). Statistical analyses were performed with the Statistical Package for Social Science (SPSS) version 21 for windows (SPSS Inc., Chicago, IL, USA) and p-value < 0.05 were considered statistically significant.

Results

Of the 998 participants with complete data, 321 (32.2%) were males and 677 (67.8%) were females. Table 1 shows the

demographic characteristics of the participants. The majority were over the age of 35 years (59.4%), attained grade level 8-12 (58.1%), earned R2000 and below (77.3%) and unemployed (47.7%). The prevalence of overweight and obesity were 24% and 46%, respectively (Figure 1). Obesity was strongly associated with; female sex, aging, being married, being government employee and retirees, and monthly income of R2000 (Table 2). There was a positive linear association between obesity and increasing age, reaching peak prevalence (67.1%) between 56-65 years.

Table 1: Demographic characteristics of the participants by sex

Variables	Male n=321 n(%)	Female n=677 [n(%)]	Total n=998 [n(%)]	p-value
Age group (years)				
18-25	40(12.5)	143(21.1)	183(18.3)	
26-35	74(23.1)	149(22.0)	223(22.3)	
36-45	67(20.9)	116(17.1)	183(18.3)	0.009*
46-55	57(17.8)	110(16.2)	167(16.7)	
56-65	41(12.8)	99(14.6)	140(14.0)	
≥66	42(14.1)	60(8.9)	102(10.2)	
Level of education				
No formal schooling	62(19.3)	84(12.4)	146(14.6)	
Grade 1-7	57(17.8)	99(14.6)	156(15.6)	0.008*
Grade 8-12	17(53.3)	409(60.4)	580(58.1)	
Tertiary	31(9.7)	85(12.6)	116(11.6)	
Monthly income (Rands)				
No income	134(41.7)	300(44.3)	445(44.6)	
R150-2000	89(27.7)	248(36.6)	326(32.7)	0.000*
R2001-5000	74(23.1)	100(14.8)	174(17.4)	
R5001and above	24(7.5)	29(4.3	53(5.3)	
Marital status				
Single	193(60.3)	444(65.6)	637(63.9)	
Married	115(35.9)	185(27.3)	300(30.1)	
Separated	1(0.3)	5(0.7)	6(0.6)	0.002*
Divorced	9(2.8)	13(1.9)	22(2.2)	
Widowed	2(0.6)	30(4.4)	32(3.2)	
Racial group				
Black	313(97.5)	666(98.4)	979(98.1)	
Coloured	8(2.8)	9(1.3)	17(1.7)	0.26
White	0(0.0)	2(0.3)	2(0.2)	
Type of employment				
Government employee	30(9.3)	33(4.9)	63(6.3)	
Non-government employment	98(30.5)	133(19.7)	231(23.2)	
Self-employment	30(9.3)	32(4.7)	62(6.2)	
Students	19(5.9)	80(11.8)	99(9.9)	0.00*
Unemployed	115(24.2)	361(53.4)	476(47.7)	
Retired	29(9.0)	37(5.5)	66(6.6)	
* Statistically significant at p ≤ 0.05				

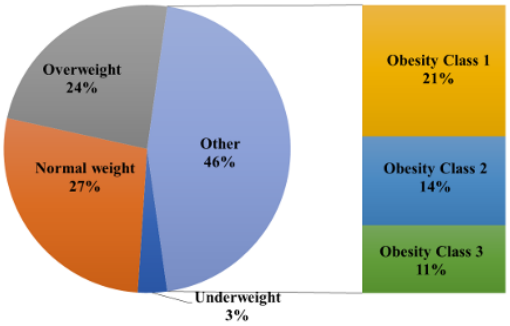

Figure 1: Percentage distribution of participants by body mass index

Table 2: Association between obesity and demographic factors

Variables	Obese n(%)	Not Obese n(%)	RR	CI	p-value
Sex					
Male	88(27.4)	233(72.6)			
Female	363(53.6)	314(46.4)	0.3	0.2-0.4	0.000*
Age(years)					
≤25	47(25.7)	136(74.3)			
26-35	91(40.8)	132(59.2)	-	-	
36-45	91(49.7)	92(50.3)			
46-55	80(47.9)	87(52.1)			0.000*
56-65	94(67.1)	46(32.9)			
≥66	48(47.1)	54(52.9)			
Level of education					
No formal schooling	56(39.4)	90(61.6)			
Grade 1 to 7	78(50.0)	78(50.0)	-	-	
Grade 8 to 12	271(46.7)	309(53.3)			0.102
Tertiary	46(39.7)	70(60.3)			
Marital status					
Never married	229(35.9)	408(64.1)			
Ever married	202(61.6)	126(38.4)	0.3	0.3-0.5	0.000*
Employment					
Government employee	38(60.3)	25(39.7)			
Non-government employee	99(42.9)	132(57.1)	-	-	0.000*
Self-employed	30(48.4)	32(51.6)			
Student	21(21.1)	78(78.8)			
Unemployed	224(47.1)	252(52.9)			
Retired	38(57.6)	28(42.4)			
Income					
Low-income earners(2000 and below)	188(52.7)	169(47.3)			
Middle-income earners (2001 and above)	104(45.8)	123(54.2)	1.3	0.9-1.8	0.063
* Statistically significant at p ≤ 0.05; RR= Relative risk; CI = Confidence interval					

Table 3 presents the bivariate associations between obesity and current smokers, smoking categories, ever drank alcohol and alcohol consumption in the preceding 12 months, vegetable servings and moderate and vigorous intensity exercises. Using the WHO criteria, vigorous-intensity activity

was significantly (p=0.005) associated with obesity. Obesity was strongly associated with pre-diabetes, hypertension and metabolic syndrome (Table 4).

Table 3: Association between obesity and behavioural risk factors

Variables	Obese n(%)	Not obese n(%)	RR	CI	P-value
Current smokers					
Yes	27(18.0)	123(82.0)			
No	424(50.0)	424(50.0)	0.2	0.1-0.3	0.000*
Smoking categories					
Primary smokers	62(41.3)	88(58.7)			
Secondary smokers	118(39.5)	181(60.5)	-	-	0.013*
Non-smokers	271(49.4)	278(50.6)			
Ever drank alcohol					
Yes	96(30.1)	233(69.9)			
No	351(52.5)	318(47.5)	0.4	0.3-0.5	0.000*
Ever drank in the past 12 months					
Yes	81(29.0)	198(71.0)			
No	136(54.4)	114(45.6)	0.3	0.2-0.5	0.000*
Fruit servings					
1-4	436(44.8)	537(55.2)			
5-7	13(59.1)	9(40.9)	0.6	0.2-1.3	0.133
Vegetable servings					
Non	13(36.1)	23(63.9)			
1-4	253(42.5)	342(57.5)	-	-	0.023*
5-7	183(50.8)	177(49.2)			
Physical Activity					
Yes	29 (19.00)	124 (81.00)	0.7	0.4-1.0	0.005*
No	215 (25.2)	630 (74.6)			

* Statistically significant at $p \leq 0.05$**;** RR= Relative risk; CI = Confidence interval

Table 4: Association between obesity and cardiovascular risk factors

Variables	Obese n(%)	Not obese n(%)	RR	CI	p-value
Pre-diabetes					
Yes	250(54.7)	207(45.3)			
No	201(37.2)	340(62.8)	2.0	1.6-2.6	0.000*
DM as defined in the study					
Yes	145(59.4)	99(40.6)			
No	306(40.6)	448(59.4)	2.1	1.6-2.9	0.000*
HTN as defined in the study					
Hypertensive	276(56.2)	215(43.8)			
Not hypertensive	175(34.5)	332(65.5)	2.4	1.9-3.1	0.000*
Comorbidity (HTN and DM)					
Yes	165(75.7)	53(24.3)			
No	286(36.7)	494(63.3)	5.4	3.8-7.6	0.000*

* Statistically significant at $p \leq 0.05$; RR= Relative risk; CI = Confidence interval

In the logistic regression model analysis, after adjusting for level of education, employment status, physical activity, alcohol consumption, and servings of fruits and vegetables, only female sex, aging, being married, hypertension, diabetes and non-smoking status were independently and significantly associated with obesity (Table 5).

Table 5: Multiple logistic regression showing predictors of obesity

Variables	Beta	Wald	AOR	p-value
Age(years)				
26 and above				
≤25(reference)	0.69	11.0	2.0(1.3-3.0)	0.001*
Marital status				
Ever married				
Never married(reference)	0.83	25.6	2.3(1.7-3.2)	0.000*
Sex				
Female				
Male(reference)	1.33	57.4	3.8(2.7-5.3)	0.000*
Hypertensive				
Yes				
No(reference)	0.73	22.1	2.0(1.5-2.8)	0.004*
Diabetes				
Yes				
No(reference)	0.37	4.0	1.4(1.0-2.0)	0.000*
Smoker				
No				
Yes(reference)	1.02	16.6	2.8(1.7-4.5)	0.005*

* Statistically significant at $p \leq 0.05$; AOR=Adjusted odd ratio

Discussion

We found a high prevalence of combined prevalence of 70.0%; overweight (24.0%) and obesity (46.0%) in our study sample. Overweight and obesity are contributing significantly to increase in morbidity and mortality worldwide with variations in the prevalence across countries and regions. Though, previously considered the problem of affluent and developed nations, however, the recent trends of increase in the prevalence in both middle and low-income countries such as South Africa shows that every region is affected.(3,4,) Our findings corroborate previous reports showing high prevalence of obesity in South Africa.(19,20) Though, we found slightly lower prevalence in comparison with those other studies which reported prevalence range of 49.7%-79.1% due to variations in the methods of sampling and population studied. Previous study by Goon et al.(12) found a prevalence of obesity of 32.5% among students at the University of Venda in South Africa. Similar trend of increasing prevalence of overweight and obesity has been reported across sub-Saharan African countries,(21,22) although, these trends are still lower than our findings. Our finding is comparable to prevalence of obesity in the high-income countries(23,24) and affirmed that South Africa suffers greater burden of obesity in comparison to other African countries. The rapid urbanization leading to epidemiological and nutritional traditions accounts for the increasing trend of overweight and obesity in South Africa. The emerging pattern of consumption of fast foods from various outlets across the country and less consumption of fruits and vegetables reported in South Africa(25) are

contributing to the epidemic of overweight/obesity. Such palatable, attractive and affordable processed foods as well as sugar-sweetened beverages are the major drivers of overweight/obesity in the communities and a rise in their availability and marketing is being anticipated.(25) Probably, these factors in combination with other unhealthy behaviours are the underlying causes for the high burden of obesity and overweight among the study population. Therefore, there is a need for urgent and effective policies addressing these issues to curtail the epidemic.

Of all the demographic factors, sex, age, marital status, employment, and income, level of education, alcohol use and physical inactivity were the significant factors associated with overweight and obesity among the study participants. These findings were similar to previous reports in South Africa and Ghana(19,26) which showed that female sex, being married, lower income, being unemployed and aging are the significant risk factors for obesity. In our study, higher prevalence of obesity was found among females and low-income earners. However, several studies outside Africa indicated that male sex is associated with a higher overweight and obesity prevalence.(7,27) The higher rate of overweight and obesity recorded among females is likely due to women's engagement in lesser physical activity level.(28) This might also explains why prevalence was higher among the married, compared to never married participants. Also, the physiological changes occurring in women after their reproductive years contribute significantly to weight gain.(29)

Consistent with Fenaughty et al., (24) obesity was associated with aging among the study participants; but contrasting other studies involving Chinese and Ugandan adults.(21,27) Old age is usually associated with lesser physical activity and correlates with age of retirement in active service. Findings from the study shows that government employee has a higher prevalence of obesity compared to others, possibly attributable to sedentary working environment and nutritional transitions. Similar finding was also reported among Namibian workers due to sedentary working condition.(30)

Findings from this study indicated that there was a significant association between obesity and smoking status, alcohol use and vegetable servings. Our results corroborate previous reports.(26,31) Current smokers are less likely to be obese in our study sample which is in agreement with previous reports showing an inadvertent weight loss among smokers.(31) Also, participants who reported ever drinking alcohol beverages were less likely to be obese. There seems to be a complex relationship between obesity and alcohol use. While some scholars argued that alcohol consumption is often accompanied by a weight gain as a result of the high amount of energy content(31,32) and associated increase in appetite, leading to weight gain. Cready and Kyle(33) found no clear cut relationship between alcohol use and obesity. They advanced that the observed weight gain among moderate alcohol users were due to gender influence and physical inactivity.

The paradox of obesity association with higher consumption of fruits and vegetables in our study should be interpreted with caution. Though fewer participants reported the consumption of five or more servings of fruits (n=22) and vegetables (n=360) per day. Vegetable and fruit consumption has been shown to be associated with a reduction in chronic disease incidences and a lesser risk for obesity due to its low calorie content.(34) It should however, be noted that the consumption or increased in the consumption of vegetables alone is not the "easy way" out of the obesity menace. The composite relationship of genetics, environmental and lifestyle factors are crucial for development of obesity. Thus vegetable consumption in the presence of physical inactivity, consumption of diets high in fat and sugar as well as genetic predisposition will make no difference.(35) This is a plausible explanation for our result in the study. Our results highlight the importance of engaging in physical activities; moderate intensity or vigorous exercises daily. Participants who engaged in moderate and vigorous exercises were less likely to be obese. This is further confirms the pathophysiological association between physical activity and the control and reduction of obesity.(36)

We found significant association between obesity and other cardiovascular diseases; hypertension and diabetes. Obese individuals are more likely to be hypertensive and diabetic. The clinic-pathological association of obesity, hypertension and diabetes have been described extensively in the literature.(37,38) Hence, our findings are not surprising but further highlights to health authorities in South Africa that time for action against obesity and other cardio-vascular diseases is now or never. This is similar to several other reports in developed countries such as USA, Central America, middle-income countries like Latin America, Mexico and African countries such as Ghana, which shows the concurrent occurrence of obesity, hypertension and diabetes, a condition called metabolic syndrome.(39) In addition, pre-diabetes was found to be significantly associated with obesity among the study participants. Pre-diabetes has been documented to be associated with obesity in several reports and more often, obesity leads to an increase in the risk of developing pre-diabetes and subsequently, diabetes mellitus.(40)

Strengths and Limitations: The cross-sectional design, convenience sampling and self-reporting of lifestyle measures are notable limitations to our study. We also did not verify that the participants had indeed observed the mandatory eight hour fasting prior to the study. Notwithstanding, the large sample size of the participants, utilization of previously validated WHO STEPwise surveillance questionnaire and the adherence to standard protocols for conducting measurements gave credence to our results.

Besides, this is the largest study on obesity prevalence in the Eastern region of Southern Africa and thus, serves as reference epidemiological data for future studies in the region. Also, our results will inform interventions towards addressing the sustainable development goal agenda of the country. Our study further calls for more research studies on the complex relationship of nutrition, genetics and environmental factors in the Eastern region of Southern Africa.

Conclusions

Findings of high prevalence of overweight and obesity in Buffalo City Metropolitan Municipality require attention of health authorities. We found evidence of nutritional (less consumption of fruits and vegetables) and epidemiological transitions (sedentary activities and aging population), culminating in higher prevalence of cardiometabolic diseases in our study population. South African policies on non-communicable diseases should therefore, target obesity control and prevention at both individual and public health level. Clinicians should also focus on promoting behavioural changes towards attaining the ideal weight during consultations at the primary health care level. Prospective studies on the nutritional and exercise interventions among South African adults will add value to our findings.

Conflict of interests: The authors declare no conflict of interest.

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Authors' Contributions: EOO, DTG and OVA conceptualised, designed and drafted the paper. AOA and ES participated in data collection and gave intellectual contribution into the manuscript. All authors read and approved the final manuscript.

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