https://doi.org/10.46389/rjd-2020-1030
www.rjdnmd.org

Rom J Diabetes Nutr Metab Dis
2020; volume 27, issue 3, pages 195-199

Original Research

Metabolic Variables Influencing Body Mass Index and Overweight: A Path Analysis within a Cross-Sectional Study

Marzieh Mahmoodi[1], Tania Dehesh[2]*, Paria Dehesh[3]

[1] Department of Biostatistics, School of Health and Nutrition, Bushehr University of Medical Sciences, Bushehr, Iran
[2] Department of Biostatistics and Epidemiology, Kerman University of Medical Sciences, Kerman, Iran
[3] Department of Epidemiology, Iran University of Medical Sciences, Tehran, Iran

*Correspondence to: Tania Dehesh, Haft Bagh Alavi, Kerman University of Medical Sciences, Iran, Kerman, Postal code: 7617647633.
E-mail: Tania_dehesh@yahoo.com. Phone: +98-34-31325069, Fax: +98-34-31325070

Received: 28 February 2020 / Accepted: 1 July 2020

Abstract

Introduction: This study aims to explore the most responsible, influential metabolic variables of Body Mass Index (BMI) and investigating their direct and indirect effect on path analysis. **Material and Methods:** 350 adults aged 18 years and older without any chronic diseases who came for an annual blood check-up were included in this study. Thyroid-Stimulating Hormone (TSH), Fasting Blood Sugar (FBS) and Thyroid-Stimulating Hormone (TSH) levels were measured using standard laboratory methods. Path analysis was carried out to examine the triglyceride (TG) mediator role in the relationship between age, FBS, and TSH on BMI. **Results:** TSH has a significant indirect effect on BMI (P=0.017). Age has both direct and indirect effects on BMI (P=0.003). Age and TSH have a direct impact on TG levels ($p < 0.05$), and the mediator of TG has a direct effect on BMI (P=0.001). **Conclusions:** Controlling some biomedical factors leads to controlling obesity as one of the main concerns in public health. Unexpectedly, TSH even had an indirect effect on BMI through TG. Also, because BMI is indirectly affected by age with the mediator of TG, controlling triglyceride along with increasing age, becomes more important.

Keywords: Biomedical factors, obesity, body mass index, triglyceride (TG), fasting blood sugar (FBS), thyroid-stimulating hormone (TSH).

Introduction

Obesity is one of the most significant public health problems globally. Overweight and obesity increase the risk of various diseases, especially heart disease, type 2 diabetes, sleep apnea blockers, certain types of cancer, bone turnover, and asthma [1-5]. As a result, one of the factors that reduce average life expectancy is obesity [1]. According to available statistics, the death rate of obesity is higher than the total mortality rate due to four common cancers (lung, breast, intestinal and prostate). Obesity has been known as one of the most preventable causes of death worldwide. On average, overweight and obesity reduce life expectancy by about 6 to 7 years [6].

Based on the World Health Organization (WHO) report in 2016, about 39% of adults above 18 years old were overweight, and 13% (11% of men and 15% of women) of them were obese [7].

In Iran, the prevalence of obesity was estimated at 21.7% in populations aged 18 years and over and 6.1% in populations below 18 years old [8].

Using BMI is the most common way of estimating overweight and obesity. In Asia, the risk of adverse health effects starts to increase progressively by increasing BMI from a value between 22 to 25 kg/m^2 [9].

Some factors can affect BMI and lead to overweight or obesity. These include individual elements such as diet, lack of exercise, environmental factors, and genetics. The accumulation of fat or triglycerides (TG) is essentially the only metabolic variables for overweighing the body [6]. However, many previous studies have shown that both TG and age are closely and independently related to BMI [10, 11]. These studies used an analysis that examines the direct effect of these variables on BMI and overweight.

Other studies have shown that some metabolic variables can affect the TG level, such as FBS and TSH [12-14].

However, none of these studies have considered all these variables together. Also, there were limitations in understanding the direct and indirect effects of these factors on BMI.

To overcome these limitations, this study aims to evaluate how the variables are related to BMI and overweight, which have been identified by other studies. To this end, we carried out a path analysis to examine the TG mediator's role in the relationship between age, FBS, and TSH on BMI.

Material and Methods

This cross-sectional study was carried out on the population referred to the best clinic in Kerman, southern Iran, for an annual check-up from March to September 2018. Three hundred fifty adults aged 18 years and older without any chronic diseases were included in the study. The subjects who had obesity of endocrine origin and pregnant and lactating women were excluded from the study.

After receiving informed consent and approval from the ethics committee of Kerman University (reference number: IR.KMU.REC.1397.174), the people were enrolled for the study.

Blood samples were collected from participants that practiced fasting. Serum samples were centrifuged at 3000 rpm for 5 min and stored at -20°C until analysis. Also, TG, FBS and TSH levels were measured using standard laboratory methods.

Weight and height were measured using standardized techniques and equipment. BMI was calculated as weight in kilograms and was divided by the square of the height in meters. BMI provides the most useful measure for overweight and obesity. The same technique was applied for both adult men and women and all ages.

For adults, the WHO defines overweight as a BMI greater than or equal to 25 and obesity as a BMI greater than or equal to 30[7].

Statistical analysis

The data are summarized as frequencies and percentages for categorical variables. Continuous variables are reported as mean ± Standard Deviation (SD).

Pearson's correlation coefficients were calculated for the evaluation of the relationship between study variables. Afterward, path analysis was used to identify factors that are influencing BMI. For the interpretation of effects, the path analysis or causal modeling was developed as a method of decomposing correlations into different parts. The method is applied to describe the direct and indirect correlations among a set of variables. Exogenous independent variables were age, TG, FBS and TSH levels. The causal assumptions were displayed in a path diagram in which the relationships were specified between variables and the causality direction.

SPSS version 20.0 was used for the descriptive statistical analysis, and AMOS version 20.0 was used for path analysis. The significance level of 0.05 was used for tests.

Results

Table 1 describes the characteristics of the 350 participants in this study. Among the 350 participants, 169 (48.3%) were male, and 181 (51.7%) were female.

A mean of 43.3 and a standard deviation of 13.94 was obtained for the age variable. There was no significant difference between the age of women and men (P =0.490).

The mean (± SD) BMI of the people was equal to 26.85 (± 5.19) kg/m^2. It appeared that the mean BMI of women was significantly higher

https://doi.org/10.46389/rjd-2020-1030

Table 1: Subject characteristics and lab values*

	Total (n = 350)	Women (n = 181)	Men (n = 169)	P-value
Age	43.3 ± 13.94	43.80 ± 13.56	42.76 ± 14.36	0.490
Education				
Under diploma	188(53.7)	104(57.5)	84(49.7)	
Diploma	100(28.6)	52(28.7)	48(28.4)	
Associate Degree	19(5.4)	5(2.8)	17(10.1)	0.128
Bachelor	34(9.7)	17(9.4)	17(10.1)	
M.S	9(2.6)	3(1.7)	6(3.6)	
BMI	26.85 ± 5.19	28.29 ± 5.53	25.31 ± 4.32	< 0.001
Underweight (<18.5)	14(4)	3(1.7)	11(6.5)	< 0.001
Normal weight (18.5-24.9)	125(35.7)	52(28.7)	73(43.2)	
Overweight (25-29.9)	123(35.1)	66(36.5)	57(33.7)	
Obesity class 1 (30-34.9)	70(20)	44(24.3)	26(15.4)	
Obesity class 2 (35-39.9)	12(3.4)	10(5.5)	2(1.2)	
Morbidity obesity (>40)	6(1.7)	6(3.3)	-	
FBS	109.08 ± 35.49	108.29 ± 6.26	109.93 ± 34.73	0.665
TSH	2.63 ± 2.06	2.81 ± 2.11	2.44 ± 2.01	0.094
TG	156.73 ± 97.12	153.04 ± 95.87	160.69 ± 98.56	0.462

*Age, BMI, FBS, TSH and TG were expressed as mean± SD. Education and BMI categories were expressed as frequency (%).

than that of men (P > 0.001). As shown, more than half of the people (60.3%) had a BMI > 25 and they were considered overweight or obese. The number of people with normal weight (BMI 18.5-24.9) was 125, and just a very small number (4%) were assumed to be underweight.

The mean (± SD) FBS was equal to 109.08 (± 35.49) mg/dL, and mean (± SD) TSH was equal to 2.63 (± 2.06) U/ml. The mean± SD TG of males was higher than that of females.

The mean± SD TG of male and female participants was equal to 153.04 95.87 and 160.69 98.56, respectively. There was no significant difference in biomedical factors (FBS, TSH and TG) between males and females (P =0.05).

Path analysis results

The path analysis was developed to examine the direct and indirect paths of variables that affect BMI. The findings of previous studies were used to define the paths of each of these variables in the hypothetical model and to identify how they affect BMI. Figure 1 illustrates a diagram of the basic model with paths created between the different study variables.

Goodness of fit

In order to assess how well this model fits the data, we used several statistical indices to check the data fit degree. The most common indices of fit are the chi-square ($\chi 2$), comparative fit index (CFI), the Normed Fit Index (NFI), the goodness of fit index (GFI), and the root mean square error of approximation (RMSEA). The analysis showed that all indices belonged to an appropriate range, and all indicated a good fit. Chi2 = 1.856 (df = 2), p = 0.392, GFI = 0.998, NFI = 0.979, CFI = 1.000, RMSEA = .000 (Table 2).

Table 3 summarizes the estimates of standardized direct, indirect and total effects of FBS, TSH, TG and age on BMI. TSH has a significant indirect effect (P=0.017) and age has both direct

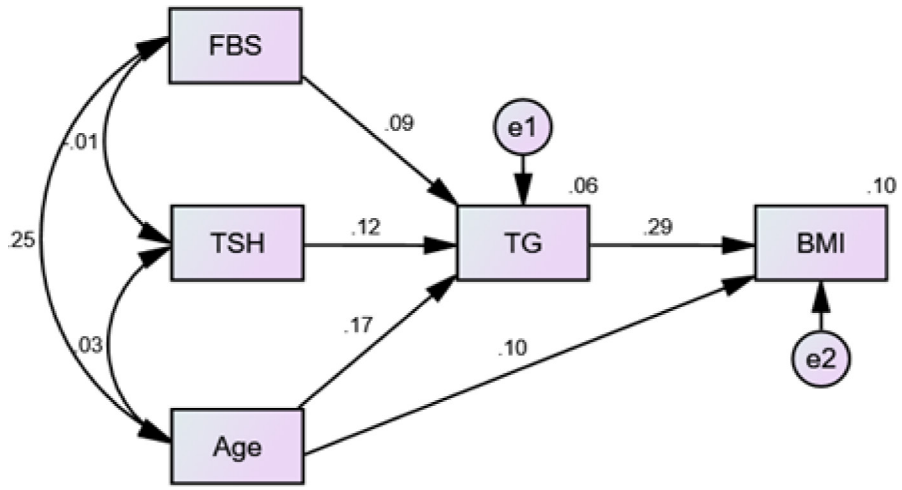

Figure 1: The path diagram of BMI effective predictors.

Table 2: Goodness of fit indices.

CMNI (χ^2)	DF	P-value	GFI	NFI	CFI	RMSEA	*CMNI/DF*
1.856	2	0.392	0.998	0.979	1	0.000	0.928

Table 3: The direct, indirect and total effects of exogenous on endogenous variables.

	Direct			Indirect			Total		
	effect	C.I	P-value	effect	C.I	P-value	effect	C.I	P-value
FBS → TG	0.086	(-0.191, 0.021)	0.109				0.086	(-0.192, 0.021)	0.109
Age → TG	0.175	(0.782, 0.258)	0.002				0.175	(0.781, 0.258)	0.002
TSH → TG	0.124	(0.015, 0.227)	0.024				0.124	(0.015, 0.227)	0.024
TG → BMI	0.288	(0.184, 0.409)	0.001				0.288	(0.184, 0.409)	0.001
Age → BMI	0.099	(0.003, 0.193)	0.041	0.051	(0.019, 0.089)	0.001	0.149	(0.051, 0.241)	0.003
FBS → BMI				0.025	(-0.004,0.061)	0.093	0.025	(-0.004,0.061)	0.093
TSH → BMI				0.036	(0.005, 0.082)	0.017	0.036	(0.005, 0.082)	0.017

and indirect effects on BMI (P=0.003). Age and TSH have a direct effect on the TG ($p<0.05$) and the mediator of TG has a direct effect on BMI (P = 0.001).

Discussion

In this study, BMI and laboratory parameters were evaluated and data were compared to find associations between these parameters. To the best of our knowledge, this is the first study using path analysis for determining the biomedical parameters of BMI. Some studies have been conducted to test the effect of each of the biochemical factors on BMI. However, the issue of whether the relationship is direct or indirect (or both) has not been considered [10-14].

According to the descriptive results of this study, more than half of the people (60.3%) were considered overweight or obese. This rate of obesity is higher than the global obesity rate of adults aged 18 years and above [7], and it should be considered a severe health problem in the Kermanian population.

The mean value of BMI of women was higher than men, and most people with overweight and obesity were women. The present study results are very similar to the results reported from other studies on the population of the north of Iran. In the study of Hajian-Tilaki,

 https://doi.org/10.46389/rjd-2020-1030

the overall prevalence of overweight and obesity was 53.6% (61.3% of women and 46.1% of men) [15]. In another study on the population of Azarbayejan of Iran, the prevalence of overweight was 36.5% (38.6% of men and 34.8% of women) and the prevalence of obesity was 33.3% (25.4% of men and 40.0% of women) [16]. In a nationwide survey of the Iranian population aged 15-65, the prevalence of overweight and obesity was 42.8% in men and 57% in women [17].

In this study, Path analysis results showed age and TSH have an indirect effect on BMI with the mediator of TG. Therefore, the TSH factor plays an essential role in reducing BMI.

Controlling TSH leads to BMI control directly. On the other hand, TSH reduces BMI indirectly by reducing TG. The previous studies found just a direct relationship. Nyrnes showed that serum TSH is positively associated with BMI [18]. The study of Shaoba showed a direct positive association between TSH levels and BMI [19] and the study of Bétry confirmed the relationship between TSH and BMI [20].

Conclusion

These findings highlight the necessity of designing programmers to control the biomedical factors associated with obesity, especially TSH. Also, because BMI and the mediator of TG are indirectly affected by age, controlling triglyceride levels is necessary at an older age.

Conflict of Interest

The authors declare no conflict of interest.

References

1. Haslam, D. and W. James, *Obesity Lancet*. 2005; 366 (9492): 1197–209. CrossRef PubMed Google Scholar.
2. Sybilski, A.J., et al., Obesity–a risk factor for asthma, but not for atopic dermatitis, allergic rhinitis and sensitization. *Public health nutrition*, 2015. 18(3): p. 530–536.
3. Poulain, M., et al., The effect of obesity on chronic respiratory diseases: pathophysiology and therapeutic strategies. *Canadian Medical Association Journal*, 2006. 174(9): p. 1293–1299.
4. Di Angelantonio, E., et al., Body-mass index and all-cause mortality: individual-participant-data meta-analysis of 239 prospective studies in four continents. *The Lancet*, 2016. 388(10046): p. 77–786.
5. Berrigan, D., R.P. Troiano, and B.I. Graubard, BMI and mortality: the limits of epidemiological evidence. *The Lancet*, 2016. 388(10046): p. 734–736.
6. Stenholm, S., et al., Body mass index as a predictor of healthy and disease-free life expectancy between ages 50 and 75: a multicohort study. *International Journal of Obesity*, 2017. 41(5): p. 769.
7. http://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight. 2018.
8. Rahmani, A., et al., Investigation of the Prevalence of Obesity in Iran: a Systematic Review and Meta-Analysis Study. *Acta Med Iran*, 2015. 53(10): p. 596–607.
9. Who, E.C., Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies. *Lancet* (London, England), 2004. 363(9403): p. 157.
10. Cuadros, J.L., et al., Body mass index and its correlation to metabolic and hormone parameters in postmenopausal Spanish women. *Gynecological Endocrinology*, 2011. 27(9): p. 678–684.
11. Mohammed, Z., et al., The association between body mass index, lipid profiles and total cholesterol among married versus spinster. *Journal of Gastroenterology and Digestive Diseases*, 2017. 2(1): p. 17–21.
12. Zhang, J., et al., Serum thyrotropin is positively correlated with the metabolic syndrome components of obesity and dyslipidemia in chinese adolescents. *International journal of endocrinology*, 2014. 2014.
13. Sheikhpour, R., F. Sadeghian, and S. Rajabi, Correlation between glycated hemoglobin, serum glucose and serum lipid levels in type 2 diabetes. *Iranian Journal of Diabetes and Obesity*, 2013. 5(1): p. 12-15.
14. Agrawal, J., N. Bharihoke, and A. Kar, Moderate correlation of fasting blood sugar with different lipid Parameters may a signal for insulin resistance in normal population. *Int J Pharm Pharm Sci*, 2014. 6(5): p. 683–685.
15. Hajian-Tilaki, K. and B. Heidari, Prevalence of obesity, central obesity and the associated factors in urban population aged 20–70 years, in the north of Iran: a population-based study and regression approach. *Obesity reviews*, 2007. 8(1): p. 3–10.
16. Nikooyeh, B., et al., Prevalence of Obesity and Overweight and Its Associated Factors in Urban Adults from West Azerbaijan, Iran: The National Food and Nutritional Surveillance Program (NFNSP). *Nutrition and Food Sciences Research*, 2016. 3(2): p. 21–26.
17. Janghorbani, M., et al., First nationwide survey of prevalence of overweight, underweight, and abdominal obesity in Iranian adults. *Obesity*, 2007. 15(11): p. 2797-2808.
18. Nyrnes, A., R. Jorde, and J. Sundsfjord, Serum TSH is positively associated with BMI. *International journal of obesity*, 2006. 30(1): p. 100.
19. Shaoba, A., et al., Serum Thyroid-Stimulating Hormone Levels and Body Mass Index Percentiles in Children with Primary Hypothyroidism on Levothyroxine Replacement. *Journal of clinical research in pediatric endocrinology*, 2017. 9(4): p. 337.
20. Betry, C., et al., Increased TSH in obesity: Evidence for a BMI-independent association with leptin. *Diabetes & metabolism*, 2015. 41(3): p. 248–251.