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Body mass index and shortened telomere length in middle-aged female and male RUNNING HEAD: Middle-aged and shortened telomere length

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Abstract:

Obesity is a risk factor associated with age-related disorders that accelerate aging, and it increases the risk of metabolic diseases. Therefore, this study was conducted to investigate the association of leukocyte telomere length (LTL) with the presence of higher body weight in middle-aged females and males. The study subjects comprised 160 (80 control and 80 higher body mass index BMI groups) with ranging ages of 30-50 years included and stratified for BMI. The physio-biochemical analysis was measured using enzymatic determination. Mean telomere length was determined by using the southern blotting technique. The association analysis revealed a significant variance ($P < 0.01$) in biochemical parameters between higher BMI groups and control including waist, lipid profile, and the level of estradiol, testosterone, follicle-stimulating hormone, and luteinizing hormone. Mean telomere length was shorter in middle-aged males compared to the females of higher BMI groups and control groups for both age groups. LTL was shorter in the overweight and obese patients compared with the control group, and these differences in LTL obese group were shorter compared to the overweight group. In conclusion, shorter telomere length was observed in middle-aged males associated with higher body weight and lipid abnormalities. Lipid/lipoprotein abnormalities can be used as a predictor for the shortened telomere length and the reduction in adiposity indices can improve the telomere length in both overweight and obese subjects.

Keywords: Gender, obesity, physio-biochemical analyses, telomere.

Introduction:

Telomeres, the repetitive sequence TTAGGG at the terminal of linear chromosomes that protect deoxynucleotide acid DNA-protein structures by constituting a loop to prevent end-to-end fusions of the chromosomes^{1,2,3}. Telomeres also prevent loss of genomic DNA at the terminal of mammalian chromosomes, thereby protecting against cell death^{4,5}. Telomere length extends to 10–15 kb in humans and decreases with age¹. In leukocytes, with each cell cycle telomeres undergo attrition leading to progressive telomere shortening with age⁶. The attrition in telomere length increases with age⁷. When telomeres attrition reaches a critical length, the cell cycle arrest or apoptosis is triggered⁶.

Telomere length averages are affected by genetic factors, and non-genetic factors including oxidative stress, inflammation, body composition, and gender^{8,9}. Telomere attrition rate increased by inflammation and oxidative stress that is increased with age and obesity^{4,5}. In general, obesity and

overweight promote inflammation and oxidative stress predictive of shorter telomeres in adults^{10,11,12}. Moreover, obesity represents one of the most important age-related disorders¹³ that accelerate aging, and it increases the risk of metabolic diseases that increase the risk of age-related disorders¹⁴. Besides obesity, leukocyte telomere length (LTL) is influenced by gender being shorter in adult males compared to adult females¹⁵. This discrepancy in the rate of telomere attrition between genders is probably caused by the effects of estrogen¹⁶. The estrogen hormone that has antioxidant properties to reduce oxidative stress and inflammation⁸, also stimulates telomerase activity by stimulating nitric oxide production¹⁷. While in males, testosterone increases susceptibility to oxidative stress that could participate in the acceleration of telomere shortening¹⁸.

The prevalence of obesity all over the world threatens public global health that has currently

reached epidemic proportions. The current research aims to evaluate the correlation between higher body weight and shortened telomere length in middle-aged females and males. According to our knowledge, there is no study regarding the relationship between higher body mass indexes and telomere length with some physio-biochemical parameters in middle-aged females and males.

Materials and Methods:

Study population

This study was conducted between May 2019-March 2020 and it was carried out at the Department of Nutrition/ Marjan Teaching Hospital/ Babylon province/Iraq. The current study was approved by Al-Qasim Green University (Approval No. 12.10.15) and informed written consent was obtained from all subjects before the initiation of the study. The study subjects comprised 160 (80 control and 80 higher BMI group) with ranging ages of 30-50 years included and stratified for BMI. Individuals with diabetes, hypertension, any chronic disease, smokers, breast cancer, hormonal disturbance, alcoholic patients, and pregnant female were excluded. The questionnaire of each subject was taken; it included age, smoking, lifestyle, diet, family history of the disease and use of hormone replacement therapy.

Weight index

The weighted index recommended by the world health organization (WHO) including body mass index (BMI) and waist circumference was included in this study. This measure was based on the heights and weights measured without shoes and with minimal clothing as the following equation $BMI = \text{weight (kg)} / \text{height}^2 \text{ (m)}^2$. BMI was classified as underweight, normal, overweight, obesity, and morbid obesity ($BMI < 18$), ($BMI 18 - 24.9$), ($BMI 25 - 29.9$), ($BMI 30-39.9$), and ($BMI > 40$) respectively¹⁹. The waist circumference was measured at the narrowest point of the torso width-wise usually just above the belly button, while the subject stood up, which was in male ≤ 102 cm and female ≤ 88 cm¹⁹.

Biochemical assay

From each subject in the study, 5 ml of fasting blood samples were collected. Two milliliters were collected into EDTA containing tubes to measure the telomere length. While the sera were collected by centrifuging at 3000 rpm for 15 min. The sera were used for the measurement of lipid profile and hormonal assay. The serum total cholesterol (TC), triglyceride (TG), and high-density lipoprotein-cholesterol (HDL-C) were analyzed by an

enzymatic determination (CHOD-PAP). The low-density lipoprotein-cholesterol (LDL-C) was calculated by the following equation: $LDL-C = TC - HDL-C - (TG \times 0.2)$. Bioassay Technology Laboratory company ELISA kit was used to measure the hormones (estradiol with catalog number E1034Hu, testosterone with catalog number E1036Hu, luteinizing hormone (LH) with catalog number E1037Hu, and follicle-stimulating hormone (FSH) with catalog number E1001Hu).

DNA extraction and telomere length

Genomic DNA was extracted from whole blood by using a Genaid kit and was quantified by Nanodrop. The southern-blotting technique was used to measure terminal restriction fragment (TRF) lengths^{20, 21}. Briefly, 2 μg of DNA was digested with restriction enzymes including *HinfI* (20 U) and *RsaI* (20 U) (Roche) for 2 h at 37°C to produce TRFs that contain both subtelomeric and telomeric repetitive sequence. Genomic DNA was digested into small fragments while the repetitive telomere sequences (TTAGGGn) remain intact according to the restriction enzyme sites. The TRFs were loaded on 0.8% agarose gel then denatured with 0.5 M NaOH/1.5 M NaCl and neutralized for 30 min in 0.5 M Tris and 1.5 M NaCl. The capillary transfer was used overnight to transfer DNA to a nylon membrane positively charged. The nylon membranes were then hybridized for 3 h in the hybridization solution with telomeric probe digoxigenin. The blotting membrane was washed 3 times with 2x SSC (3 M NaCl, 0.3 M sodium citrate, pH 7.0). The telomeric probe was revealed by the digoxigenin luminescent procedure after being exposed to X-ray film. As the telomeres shorten with age, all samples were taken at the same age group (30-40, 41-50) to determine the telomere length.

Statistical analysis

SPSS v23.0 (IBM, NY, USA) was used to calculate association analysis. Means of BMI group and equal variances of the normalized data were tested with the Kolmogorov-Smirnov test. The significant effect of the BMI group, sex and age group on the various parameters studied were performed with the following model:

$$Y_{ijkl} = \mu + G_i + S_j + A_k + (GSA)_{ijk} + e_{ijkl}$$

where Y_{ijkl} = phenotypic traits, μ = overall mean, G_i = fixed effect of i^{th} BMI group (i = control, overweight, obese), S_j = fixed effect of j^{th} sex (j = male, female), A_k = fixed effect of k^{th} age group (30-40, 41-50), $(GSA)_{ijk}$ = the interaction effect and e_{ijkl} = random residual error associated

with Y_{ijkl} . Multiple pairwise comparisons between main factors were performed using a Tukey test with Bonferroni corrections, which was statistically significant at the level of $P < 0.05$. To examine the relationship between telomere lengths with other phenotypic parameters, multiple linear regression analysis was used. Pearson correlation analyses were used to analyze the correlation with significance at $P < 0.05$. Preliminary statistical analysis indicated the effect of two-factor interaction did not have a significant effect on phenotypic traits, so they were not matched in the general linear model.

Results :

Results of the association analysis showed a significant difference ($P < 0.01$) in biochemical parameters between higher BMI and control groups (Table 1 and Table 2). There was significant elevation ($P < 0.01$) in the waist and lipid profile in both overweight and obese patients compared to the control group, in male compared to the female and age group (30-40 years) compared to the (41-50 years). Moreover, the results showed a significant reduction ($P < 0.01$) in the level of estradiol, testosterone, FSH, LH, and telomere length in the higher BMI group compared to the control group, also this reduction in male compared to the female and age group (30-40 years) compared to the (41-50 years) (Table 2).

The regression analysis of telomere length with study parameters persisted the biochemical changes investigated in this study (Table 3). There was a linear increase in leukocyte telomere length with sex ($\beta = 0.38$, CI (95%) = 0.33 to 0.96), HDL ($\beta = 0.69$, CI (95%) = 0.42 to 2.84) and estradiol ($\beta = 0.01$, CI (95%) = 0.001 to 0.03) respectively. Shorter leukocyte telomere length was associated with age ($\beta = -0.53$, CI (95%) = -1.08 to 0.30), BMI ($\beta = -0.73$, CI (95%) = -0.93 to 0.07), waist ($\beta = -$

0.76, CI (95%) = -1.04 to 0.92), cholesterol ($\beta = -2.03$, CI (95%) = -3.92 to -1.26), TG ($\beta = -0.68$, CI (95%) = -1.55 to 0.47), LDL ($\beta = -1.50$, CI (95%) = -2.34 to 0.51), and LH ($\beta = -0.53$, CI (95%) = -1.05 to 0.94) respectively. Moreover, Pearson's correlation analysis was used to assess the correlation between the telomere length and variable parameters (Table 4). Telomere length was found to correlate positively and significantly with sex ($r = 0.38$, $P < 0.05$), and estradiol ($r = 0.61$, $P < 0.05$), while significant negative correlation was found between telomere length and other variable parameters including age ($r = -0.53$, $P < 0.05$), BMI ($r = -0.73$, $P < 0.05$), waist ($r = -0.62$, $P < 0.05$), cholesterol ($r = -0.72$, $P < 0.05$), LDL ($r = -0.73$, $P < 0.05$), VLDL ($r = -0.49$, $P < 0.05$), and testosterone ($r = -0.39$, $P < 0.05$).

The detection of terminal restriction fragments (TRFs) of genomic DNA of control and higher BMI subjects measured in kilobase pairs (Kb) is shown in Figure 1 and Table 2. Telomere length analysis in control and higher BMI subjects according to the gender showed that telomere length (TL) was variant between male and female (Table 2). Telomere length mean was shorter in males compared to females of control subjects for both age groups (12.56 bp) vs. (14.16 bp) and (11.53 bp) vs. (12.86 bp) and these differences decreased as aging increased. In higher BMI subjects, this gender difference in TL was revealed among the overweight and obese patients as shown in Table (2). TL was shorter in the overweight and obese patients compared to the control subjects were, the obese male (10.43) of age (30-40) were longer compared to the obese male (9.13) of age (41-50). While obese females (11.13) of age (30-40) were longer compared to the obese female (10.23) of age (41-50). Both obese males and females for both age groups were shorter compared to the overweight male and female age groups.

Table 1. Comparison of some biochemical parameters among BMI groups according to gender and age groups

Gender	Age groups (years)	BMI groups	Indices (LSM ± SE)						P-value
			WC (cm)	Cholesterol (mmol/l)	TG (mmol/l)	HDL (mmol/l)	LDL (mmol/l)	VLDL (mmol/l)	
Men (80)	30-40 (40)	Control	90.00±10.11	2.86±0.03	0.81±0.02	1.60±0.02	1.34±0.02	0.16±0.01	0.001
		Overweight	95.33±8.21	4.36±0.04	1.13 ± 0.03	1.33±0.03	1.69±0.02	0.31±0.01	0.001
		Obese	106.00±7.12	4.66±0.31	1.56± 0.43	0.93±0.03	3.22±0.01	0.37±0.02	0.001
	41-50 (40)	Control	95.00±10.21	3.76±0.32	1.30± 0.44	1.40±0.01	2.60±0.04	0.46±0.01	0.001
		Overweight	100.66±9.22	5.13±0.42	1.70±0.22	1.10±0.03	3.49±0.04	0.54±0.03	0.001
		Obese	114.33±8.21	5.63±0.51	2.20 ±0.05	0.70±0.02	3.90±0.05	0.60±0.04	0.001
Women (80)	30-40 (40)	Control	81.00±9.11	2.11±0.02	0.73±0.02	1.90±0.01	1.33±0.02	0.14±0.03	0.001
		Overweight	90.66±10.23	3.13±0.34	1.00±0.05	1.53±0.01	1.58±0.05	0.28±0.01	0.001
		Obese	100.33±8.52	3.26±0.32	1.30±0.24	1.13±0.03	3.00±0.03	0.33±0.03	0.001
	41-50 (40)	Control	90.66±9.21	2.66±0.41	0.86±0.34	1.53±0.03	2.28±0.04	0.38±0.02	0.001
		Overweight	95.33±9.31	4.23±0.22	1.36±0.33	1.13±0.02	2.96±0.06	0.40±0.04	0.001
		Obese	110.33±7.22	5.43±0.34	1.76 ±0.21	0.71±0.01	3.61±0.07	0.58±0.04	0.001

LSM ± SE, Least square means ± Standard error; BMI, body mass index; WC, waist circumference; TG, triglyceride; HDL, high-density lipoprotein; LDL, low-density lipoprotein; VLDL, very low-density lipoprotein. The P-value with statistical significance is indicated in bold numbers.

Table 2. Comparison of reproductive hormones and telomere length among BMI groups according to gender and age groups

Gender	Age group (years)	BMI group	Indices (LSM ± SE)					P-value
			E (pg/ml)	T (ng/ml)	FSH (mIU/ml)	LH (mIU/ml)	Telomere length (Kb)	
Men (80)	30-40 (40)	Control	3.08±0.23	11.83±0.44	12.08±0.32	6.13±0.23	12.56±0.93	0.001
		Overweight	6.23±0.92	9.50±0.92	8.13±0.72	5.50±0.42	11.56±1.21	0.001
		Obese	8.32±0.83	5.18±1.32	7.13±1.21	3.66±0.32	10.43±1.11	0.001
	41-50 (40)	Control	4.33±0.42	11.31±1.22	11.17±1.32	5.50±0.53	11.53±0.82	0.001
		Overweight	6.24±0.92	8.34±0.83	8.04±0.93	3.66±0.21	10.33±1.21	0.001
		Obese	9.43±0.84	4.18±1.11	6.70±0.72	2.50±0.42	9.13±1.23	0.001
Women (80)	30-40 (40)	Control	38.08±1.36	0.28±0.02	34.34±1.23	24.13±0.31	14.16±1.23	0.001
		Overweight	23.23±1.20	0.39±0.01	22.58±1.40	16.76±0.42	12.33±0.92	0.001
		Obese	20.01±2.21	0.42±0.01	17.56±2.32	10.27±2.22	11.13±1.23	0.001
	41-50 (40)	Control	32.41±2.20	0.33±0.03	20.54±1.31	20.90±1.12	12.86±0.98	0.001
		Overweight	20.66±3.11	0.50±0.02	14.06±2.31	16.03±2.31	11.13±0.99	0.001
		Obese	19.75±2.62	0.66±0.03	11.44±1.11	6.90±1.12	10.23±1.12	0.001

LSM ± SE, Least square means ± Standard error; BMI, body mass index; E, Estradiol; T, Testosterone; FSH, Follicle stimulating hormone; LH, Luteinizing hormone. The P-value with statistical significance is indicated in bold numbers.

Table 3. Association analysis of telomere length with anthropometric and biochemical parameters

Variables	Regression coefficient (β)	Confidence interval (95%)	P-value
Gender	0.38	0.33 to 0.96	0.001
Age	-0.53	-1.08 to 0.30	0.001
Body mass index(BMI)	-0.73	-0.93 to 0.07	0.001
Waist circumference(cm)	-0.76	-1.04 to 0.92	0.001
Cholesterol (mmol/l)	-2.03	-3.92 to -1.26	0.001
Triglyceride (TG)(mmol/l)	-0.68	-1.55 to 0.47	0.001
High density lipoprotein(HDL) (mmol/l)	0.69	0.42 to 2.84	0.012
Low density lipoprotein (LDL) (mmol/l)	-1.50	-2.34 to 0.51	0.019
Very low density lipoprotein (VLDL) (mmol/l)	-0.35	-1.27 to 0.08	0.194
Estradiol (pg/ml)	0.01	0.001 to 0.03	0.009
Testosterone (ng/ml)	-0.39	-1.01 to 0.50	0.065
Follicle stimulating hormone (FSH) (mIU/ml)	-0.22	-1.002 to 0.42	0.094
Luteinizing hormone (LH) (mIU/ml)	-0.59	-1.05 to 0.94	0.001

P < 0.05, Significant; P > 0.05, Non-significant. The P-value with statistical significance is indicated in bold numbers.

Table 4. Correlation among telomere length with anthropometric and biochemical parameters

Variables	Telomere length(Kb)	
	r	P-value
Gender	0.38	0.021
Age	-0.53	0.001
Body mass index(BMI)	-0.73	0.001
Waist circumference(cm)	-0.62	0.001
Cholesterol (mmol/l)	-0.72	0.001
Triglyceride (TG)(mmol/l)	-0.02	0.886
High density lipoprotein (HDL)(mmol/l)	0.03	0.830
Low density lipoprotein (LDL) (mmol/l)	-0.73	0.001
Very low density lipoprotein(VLDL) (mmol/l)	-0.49	0.002
Estradiol (pg/ml)	0.61	0.001
Testosterone (ng/ml)	-0.39	0.018
Follicle stimulating hormone (FSH) (mIU/ml)	-0.09	0.588
Luteinizing hormone (LH) (mIU/ml)	0.02	0.866

P < 0.05, Significant; P > 0.05, Non-significant. The P-value with statistical significance is indicated in bold numbers.

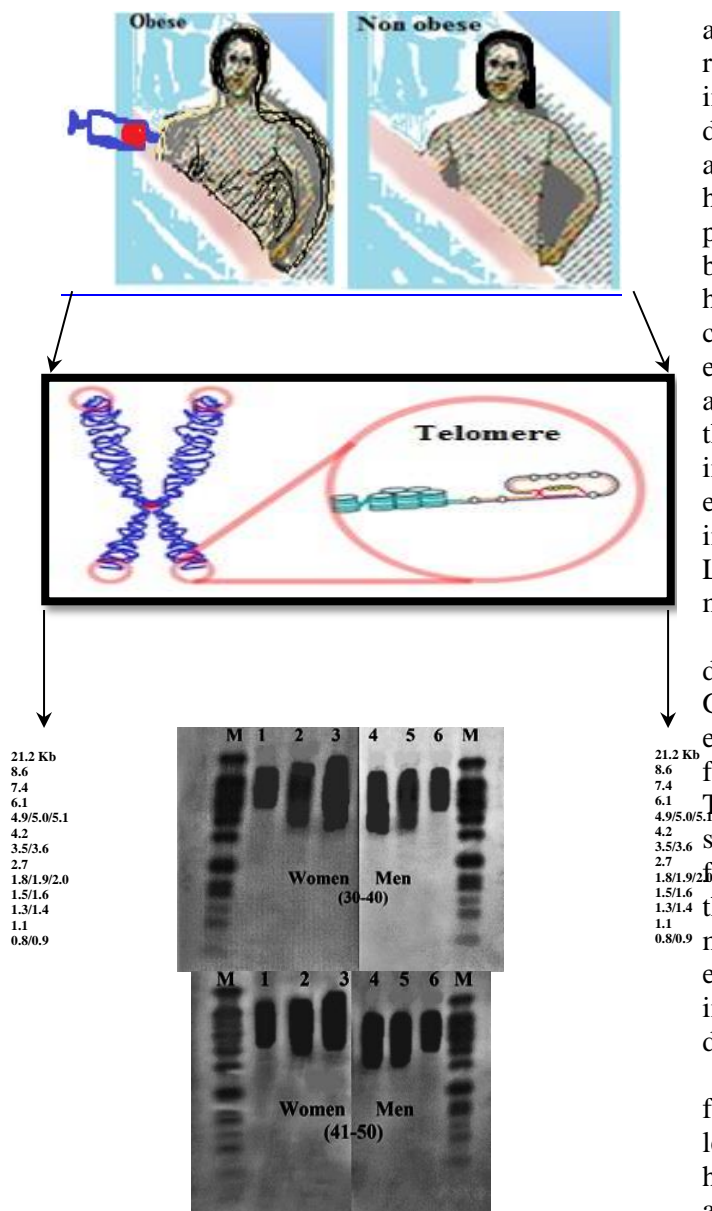


Figure 1. A schematic diagram of the current study to assess the shortened telomere length in higher body mass index of both female and male. M; Refers to DNA size marker (0.8-21.2 Kb), lane 1, and 6 represent the obese patients, lane 2 and 5 represent the overweight patients, and lane 3 and 4 represent the control subjects.

Discussion :

The present study investigated some anthropometric-biochemical parameters and the length of telomere in middle-aged females and males. The study revealed significant elevation ($P < 0.01$) in the waist circumference and lipid profile in overweight and obese patients compared to the control group, also in males compared to the females and age group (41-50 years) compared to the (30-40 years). Body mass index and waist circumference are widely used as a marker of adiposity and atherogenic indices²². Lipid

abnormalities and atherogenic indices have been revealed in obese and overweight subjects, including elevated cholesterol, triglycerides, and decreased HDL cholesterol levels^{23, 24}. These lipid abnormalities and the prevalence of obesity are higher in males compared to females^{25, 26}. The possible explanation for the gender difference might be due to biological gender differences²⁷. Estrogen has atheroprotective effects on serum lipid concentrations that can reduce the development of early lesions of atherosclerosis. Estradiol through atheroprotective effects can reduce lipid deposits in the endothelium, with a decrease in LDL-C and an increase in HDL-C in the plasma²⁸. Besides, the estrogen effect in females is of greater activity in an improvement of the blood lipid profile by removing LDL and VLDL from the plasma compared to males²⁹.

Overweight and obesity are one of the most dangerous public health that increases with age³⁰. Generally, the risk of obesity increases with age especially middle age³¹. Middle age is the main risk factor of obesity in both males and females^{32, 33}. This may belong to the visceral fat and subcutaneous abdominal fat, which are the riskiest factors for insulin resistance and metabolic diseases that increase with aging and reach peak values at middle age³². While at older ages, the relative effects of obesity likely decrease because individuals are more likely to develop metabolic diseases independent of obesity³⁴.

Studies have shown that overweight and obese females and males exhibit a significant reduction in levels of estradiol, testosterone, FSH, and LH hormones compared to the control group. Obesity is an increasingly common health risk that causes many female reproduction disorders. Higher body mass is reported to inhibit estradiol production by the ovary and causes the functional impairment of the granulosa cells³⁵. Additionally, the low levels of gender hormone-binding globulin (SHBG) in overweight and obese females result in decreased estrogen inactivation and consequently lower levels of estradiol³⁶. Besides, obesity decrease FSH and LH level by decreasing sensitivity and feedback inhibition of the hypothalamic-pituitary-gonadal (HPG) axis that results in blunted LH responsiveness to gonadotropin stimulation³⁷. FSH is also lower in females with obesity and overweight. HPG axis sensitivity may be relatively reduced in obese females that led to a decrease in FSH³⁸. This functional impairment happened by increased free fatty acids incorporation into the hypothalamic-pituitary-ovarian axis at the level of the pituitary leading to pausing gonadotropin gene translation affecting LH and FSH synthesis and/or

secretion³⁹. Moreover, in overweight and obese males, low testosterone levels with elevated estradiol (E2) level results from an up-regulated aromatase activity suppress the HPG axis⁴⁰. Elevated estradiol levels may also affect gonadotropin-releasing hormone (GnRH), LH, and FSH release, resulting in hypogonadotropic hypogonadism and decreased fertility in overweight and obese male subjects^{41,42}. Decreased FSH and levels of LH are reported in obese adult males⁴³.

Regarding the telomere length, the current results showed that subjects with overweight and obese were lower telomere length. Obesity disorder causes the accumulation of excess fat in adipose tissue; this continuous accumulation results in increased oxidative stress and inflammation⁴⁴ and releases inflammatory cytokines⁴⁵. The adipokines and pro-inflammatory cytokines that are associated with obesity cause oxidative damage of DNA and shorter telomere length²⁶. Compared to genomic DNA, telomeric DNA is relatively less capable of DNA repair, so the acute oxidative damage of the G-rich telomeric sequence can accelerate telomere loss with each cell cycle leading to senescence¹². Besides, shorter telomeres lengths were recorded in males compared to their females counterparts. This may be due to the estrogen effect in female that is thought to activate telomerase, an enzyme that lengthens telomeres by adding TTAGGG repeats⁶.⁴⁶ Additionally, estrogen has antioxidant properties that may protect telomeres against increased oxidative stress and damage telomeres⁴⁶. Estrogen directly activates the telomerase promoter through phosphoinositol-3-kinase/Akt and nitric oxide pathways and indirectly affects DNA repair through the P53 pathway⁴⁷. In contrast, testosterone in males lacks antioxidant properties that may increase the deleterious effects of oxidative stress on telomeres. Additionally, the larger body size in males causes more cell divisions leading to shorter telomeres⁴⁶.

Conclusion:

Shorter telomere length was observed in middle-aged males associated with higher body weight and lipid abnormalities. Lipid/lipoprotein abnormalities can be used as a predictor for the shortened telomere length and the reduction in adiposity indices can improve the telomere length in both overweight and obese subjects.

Author's declaration:

- Conflicts of Interest: None.
- I hereby confirm that all the Figures and Tables in the manuscript are mine. Besides, the Figures and images, which are not mine, have been

given permission for re-publication attached with the manuscript.

- The author has signed an animal welfare statement.
- Ethical Clearance: The project was approved by the local ethical committee in the University of Al-Qasim Green.

References

1. Buxton JL, Das S, Rodriguez A, Kaakinen M, Alves A C, Sebert S, et al. Multiple measures of adiposity are associated with mean leukocyte telomere length in the northern Finland birth cohort 1966. *PLoS one*. 2014; 9(6).
2. Al-Thuwaini TM. Association of antidiabetic therapy with shortened telomere length in middle-aged Type 2 diabetic patients. *J Diabetes Metab Disord*. 2021; 1-8.
3. Vasilopoulos E, Fragkiadaki P, Kalliora C, Fragou D, Docea AO, Vakonaki E, et al. The association of female and male infertility with telomere length (Review). *Int J Mol Med*. 2019; 44(2): 375-389.
4. Milte CM, Russell AP, Ball K, Crawford D, Salmon J, McNaughton SA. Diet quality and telomere length in older Australian men and women. *Eur J Nutr*. 2018; 57(1): 363-372.
5. Louzon M, Coeurdassier M, Gimbert F, Pauget B, de Vauflery A. Telomere dynamic in humans and animals: Review and perspectives in environmental toxicology. *Environ Int*. 2018; 131: 105025.
6. Nguyen MT, Lycett K, Vryer R, Burgner DP, Ranganathan S, Grobler AC, et al. Telomere length: population epidemiology and concordance in Australian children aged 11–12 years and their parents. *BMJ open*. 2019; 9 (Suppl 3): 118-126.
7. Benetos A, Okuda K, Lajemi M, Kimura M, Thomas F, Skurnick J, et al. Telomere length as an indicator of biological aging: the gender effect and relation with pulse pressure and pulse wave velocity. *Hypertension*. 2001; 37(2): 381-385.
8. Ghimire S, Hill CV, Sy FS, Rodriguez R. Decline in telomere length by age and effect modification by gender, allostatic load and comorbidities in National Health and Nutrition Examination Survey (1999-2002). *PLoS one*. 2001; 14(8).
9. Grunnet LG, Pilgaard K, Alibegovic A, Jensen CB, Hjort L, Ozanne SE, et al. Leukocyte telomere length is associated with elevated plasma glucose and HbA1c in young healthy men independent of birth weight. *Sci Rep*. 2019; 9(1): 1-8.
10. Carroll JE, Esquivel S, Goldberg A, Seeman TE, Effros RB, Dock J, et al. Insomnia and telomere length in older adults. *Sleep*. 2016; 39(3): 559-564.
11. Tucker LA. Physical activity and telomere length in US men and women: An NHANES investigation. *Prev Med*. 2017; 100: 145-151.
12. Kim S, Parks CG, DeRoo LA, Chen H, Taylor JA, Cawthon RM, et al. Obesity and weight gain in adulthood and telomere length. *Cancer Epidemiology and Prevention Biomarkers*. 2009; 18(3): 816-820.

13. Karam JG. Secondary causes of obesity. *Clinical Practice*. 2007; 4(5): 641.
14. Csige I, Ujvarosy D, Szabo Z, Lorincz I, Paragh G, Harangi M, et al. The Impact of Obesity on the Cardiovascular System. *J Diabetes Res*. 2018; 3407306.
15. Factor-Litvak P, Susser E, Kezios K, McKeague I, Kark JD, Hoffman M, et al. Leukocyte telomere length in newborns: implications for the role of telomeres in human disease. *Pediatrics*. 2016; 137(4): e20153927.
16. Panahi Y, Moghaddam FS, Babaei K, Eftekhari M, Badv RS, Eskandari MR, et al. Sexual Dimorphism in Telomere Length in Childhood Autism. *medRxiv*. 2020.
17. Lee DC, Im JA, Kim JH, Lee HR, Shim JY. Effect of long-term hormone therapy on telomere length in postmenopausal women. *Yonsei Med J*. 2005; 46(4): 471-479.
18. Shin D, Shin J, Lee KW. Effects of Inflammation and Depression on Telomere Length in Young Adults in the United States. *J Clin Med*. 2019; 8(5): 711.
19. Mathers C, Fat DM, Boerma JT, World Health Organization. The global burden of disease: 2004 update. Geneva, Switzerland: World Health Organization; 2008.
20. Benetos A, Gardner JP, Zureik M, Labat C, Xiaobin L, Adamopoulos C, et al. Short telomeres are associated with increased carotid atherosclerosis in hypertensive subjects. *Hypertension*. 2004; 43(2): 182-185.
21. Adaikalakoteswari A, Balasubramanyam M, Mohan V. Telomere shortening occurs in Asian Indian Type 2 diabetic patients. *Diabet Med*. 2005; 22(9): 1151-1156.
22. Ugwuja EI, Ogbonna NC, Nwibo AN, Onimawo IA. Overweight and obesity, lipid profile and atherogenic indices among civil servants in Abakaliki, South Eastern Nigeria. *Ann Med Health Sci Res*. 2013; 3(1): 13-18.
23. Natah TM. Serum adiponectin levels in pre-postmenopausal metabolic syndrome women and the correlation with some physio-biochemical parameters. *Aust J Basic Appl Sci*. 2014; 8(17): 360-366.
24. Suneetha K. Study of Lipid Profile in Obese and Non-obese Students in Acharya Nagarjuna University. *Int J Pharm Clin Res*. 2018; 10(2): 40-42.
25. Chooi YC, Ding C, Magkos F. The epidemiology of obesity. *Metabolism*. 2019; 92: 6-10.
26. Ramachandran V. Evaluation of Lifestyle of Middle Age People Related to Obesity. *Adv Obes Weight Manag Control*. 2018; 8(1): 00216.
27. García-Calzón S, Molerés A, Marcos A, Campoy C, Moreno LA, Azcona-Sanjulián MC, et al. Telomere Length as a Biomarker for Adiposity Changes after a Multidisciplinary Intervention in Overweight/Obese Adolescents: The EVASYON Study. *PLoS ONE*. 2014; 9(2): e89828.
28. Ali Z, Al-Zaidi MS. The association between body mass index, lipid profile and serum estradiol levels in a sample of Iraqi diabetic premenopausal women. *Oman Med J*. 2011; 26(4):263.
29. Romero-Moraleda B, Lozano ABP, Martínez EM, López-Plaza B, Candela CG, Montero FJC, et al. Lipid profile response to weight loss program in an overweight and obese patient is related with gender and age. *Nutr Hosp*. 2015; 31(6): 2455-2464.
30. Coll JL, del Mar Bibiloni M, Salas R, Pons A, Tur JA. Prevalence and related risk factors of overweight and obesity among the adult population in the Balearic Islands, a Mediterranean Region. *Obes Facts*. 2015; 8(3): 220-233.
31. Nagarkar AM, Kulkarni SS. Obesity and its effects on health in middle-aged women from slums of Pune. *J Midlife Health*. 2018; 9(2):79.
32. Villareal DT, Apovian CM, Kushner RF, Klein S. Obesity in older adults: technical review and position statement of the American Society for Nutrition and NAASO. *Am J Clin Nutr*. 2005; 13(11): 1849-1863.
33. Rodríguez-Martín A, Ruiz JN, Nieto JM, Jiménez LE. Lifestyle factors associated with overweight and obesity among Spanish adults. *Nutr Hosp*. 2009; 24(2): 144-151.
34. Finkelstein EA, Brown DS, Trogdon JG, Segel JE, Ben-Joseph RH. Age-specific impact of obesity on prevalence and costs of diabetes and dyslipidemia. *Value Health*. 2007; 10: S45-S51.
35. De Pergola G, Maldera S, Tartagni M, Pannacciulli N, Loverro G, Giorgino R. Inhibitory effect of obesity on gonadotropin, estradiol, and inhibin B levels in fertile women. *Obesity*. 2006; 14(11): 1954-1960.
36. Freeman EW, Sammel MD, Lin H, Gracia CR. Obesity and reproductive hormone levels in the transition to menopause. *Menopause*. 2010; 17(4): 718.
37. Lee HY, Lee YJ, Ahn MB, Cho WK, Suh BK. The effect of overweight on the luteinizing hormone level after gonadorelin stimulation test in girls with idiopathic central precocious puberty. *Ann Pediatr Endocrinol Metab*. 2018; 23(4): 215-219.
38. Al-Thuwaini T. Association between polymorphism in BMP15 and GDF9 genes and impairing female fecundity in diabetes type 2. *Middle East Fertil Soc J*. 2020; 25(1): 1-10.
39. Chosich J, Bradford AP, Allshouse AA, Reusch JE, Santoro N, Schauer IE. Acute recapitulation of the hyperinsulinemia and hyperlipidemia characteristic of metabolic syndrome suppresses gonadotropins. *Obesity*. 2017; 25(3): 553-560.
40. Bekaert M, Van Nieuwenhove Y, Calders P, Cuvelier CA, Batens AH, Kaufman JM, et al. Determinants of testosterone levels in human male obesity. *Endocrine*. 2015; 50(1): 202-211.
41. Amjad S, Baig M, Zahid N, Tariq S, Rehman R. Association between leptin, obesity, hormonal interplay and male infertility. *Andrologia*. 2019; 51(1): e13147.
42. Bellastella G, Menafrà D, Puliani G, Colao A, Savastano S. How much does obesity affect the male reproductive function?. *Int J Obes Supp*. 2019; 9(1): 50-64.

43. Yamaçake KGR, Cocuzza M, Torricelli FCM, Tiseo BC, Frati R, Freire G C, et al. Impact of body mass index, age and varicocele on reproductive hormone profile from elderly men. *Int. braz J Urol.* 2016; 42(2): 365-372.
44. Rogge MM, Gautam B. Biology of obesity and weight regain: Implications for clinical practice. *J Am Assoc Nurse Pract.* 2017; 29(S1): S15-S29.
45. Mangge H, Herrmann M, Almer G, Zelzer S, Moeller R, Horejsi R, et al. Telomere shortening associates with elevated insulin and nuchal fat accumulation. *Sci Rep.* 2020; 10(1): 1-9.
46. Axson EL, Peterson KE, Tellez-Rojo MM, Goodrich JM, Meeker J, Mercado-García A, et al. Sex Differences in Telomere Length Are Not Mediated by Sex Steroid Hormones or Body Size in Early Adolescence. *Gend. Genome.* 2018; 2(3): 68-75.
47. Desmawati D, Sulastri D, Lestari Y, Jamsari J. Correlation between phytoestrogens intake with telomere length in Minangkabau premenopausal women. *Asian J Pharm Clin Res.* 2018; 11(11): 499-502.

دليل كتلة الجسم وقصر طول التيلومير عند النساء والرجال في متوسط العمر العنوان الدوار: متوسط العمر وقصر طول التيلومير

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الخلاصة

السمنة هي عامل الخطر المرتبط بالاضطرابات المرتبطة بالعمر والتي تسرع الشيخوخة، وتزيد من خطر الإصابة بأمراض الابيض الغذائي. لذلك، أجريت هذه الدراسة لتحري عن ارتباط طول التيلومير في الكريات البيض (LTL) وزيادة وزن الجسم في النساء والرجال في منتصف العمر. شملت مجاميع الدراسة 160 (80 مجموعة سيطرة و80 مجموعة مؤشر كتلة الجسم عالي) مع أعمار تراوحت بين 30-50 سنة وتم مطابقتها لمؤشر كتلة الجسم. تم قياس التحاليل الفسلجية-الكيموحيوية باستخدام التحديد الأنزيمي. تم تحديد متوسط طول التيلومير باستخدام تقنية وصمة سودرن. أظهرت تحاليل الارتباط تبايناً معنوياً ($P < 0.01$) في المعايير الكيموحيوية بين مجاميع مؤشر كتلة الجسم الأعلى ومجموعة السيطرة بما في ذلك الخصر وصورة الدهون ومستوى الاستراديول والتستوستيرون والهرمون المحفز للجريبات والهرمون اللوتيني. كان متوسط طول التيلومير أقصر عند الذكور في منتصف العمر منه في الإناث في مجاميع مؤشر كتلة الجسم الأعلى ومجاميع السيطرة لكلا المجموعتين العمريتين. كان LTL أقصر في المرضى الذين يعانون من زيادة الوزن والسمنة مقارنة مع مجموعة السيطرة، وكانت هذه الاختلافات في LTL لمجموعة السمنة أقصر من مجموعة الوزن الزائد. في الاستنتاج، لوحظ قصر طول التيلومير في الرجال عند متوسط العمر الذين يعانون من زيادة الوزن و اضطراب الدهون. يمكن استخدام اضطراب الدهون / البروتين الدهني كمؤشر على قصر طول التيلومير ويمكن أن يؤدي تقليل مؤشرات السمنة إلى تحسين طول التيلومير في الأشخاص الذين يعانون من زيادة الوزن والسمنة.

الكلمات المفتاحية: الجنس، السمنة، التحاليل الفسلجية-الكيموحيوية، التيلومير.