RESEARCH ARTICLE OPEN ACCESS

Influence of Parents Socioeconomic Status on Newborn Telomere Length

Sadia Farrukh

Department of Community Health Sciences, Aga Khan University, Karachi, Pakistan

ARTICLE HISTORY

Received: April 21, 2024
Revised: July 29, 2024
Accepted: July 30, 2024

Citation: Farrukh S. Influence of parents socioeconomic status on newborn telomere length. Acad Res. 2024; 1(1): 2-5.

DOI: https://doi.org/10.70349/ar.v1i1.4

Abstract

Background: Telomeres, the marker of biological aging, are substantially influenced by parental untoward exposures and their socioeconomic status (SES). This study aimed to find the association between parents–newborn leukocyte telomere length (LTL) among different SES highlighting reprogramming during fetal life.

Methods: The parents' and newborn blood samples (n = 612, 204 each) were collected from September 2021 and July 2022, from Ziauddin Hospitals, Karachi. The real time PCR was used to quantify telomere length (T/S ratio). IBM statistical package for the social sciences (SPSS) was used to carry out analyses and graphs were formed by using GraphPad prism. A P-value of <0.05 was considered statistically significant.

Results: The mean age of mothers range between 25-35 (27.5%) and fathers <25 years (55.9). The mothers and their newborns in the upper middle SES had significantly longer LTL (2.7±1.30, 2.14±1.39, p<0.001). Whereas low SES group showed insignificant difference between (Newborn vs. mother). Among father newborns upper middle and high SES groups showed significant differences in TL (p=0.001). Longer TL was seen in father-newborn of the upper middle group (2.69+1.37; 2.79+1.30) with significant difference (p=0.001).

Conclusion: Newborns had longer TL compared to their parents, highlighting the in-utero reprogramming in all socioeconomic groups. These findings show the importance of risk factors and their comprehensive understanding and their significance in contributions during vital beginning period of newborns' TL.

Keywords: Telomere, telomerase, telomere length (TL), socioeconomic status (SES).

1. INTRODUCTION

The socioeconomic status (SES), which reflects their standing in society, is assessed across various parameters such as geographic location, education, wealth, income and occupation [1]. In the current era of scientific and economic progress, there is a growing disparity in socioeconomic conditions, particularly in developing nations like Pakistan, leading to widespread health challenges. According to the World Health Organization (WHO), Pakistan has a national poverty rate of 22%, with poverty rates among the middle class (both lower and upper) standing at 40% and 84.5%, respectively [2]. Low SES is associated with age-related ailments and premature mortality, acting as catalysts for biological processes linked to social disadvantages. This exposes individuals to various health issues affecting their physical, mental, and behavioral well-being [3].

Human telomeres, less than 1% of the entire genome, are the long non-coding tandem repeat sequences (TTAGGG), comprising nearly 150 million base pairs. With each cell division, telomeres shorten due to functional inability of DNA polymerase to complete synthesis of the DNA lagging strand [4]. Telomeres become critically short after approximately 50–70 cell divisions, known as the Hayflick limit. This activates the cell death that is cellular apoptosis triggering p53 protein [5].

Prenatal stress and environmental factors can also lead to telomere shortening, significantly influencing aging and overall quality of life [3]. Environmental factors such as reactive oxygen species (ROS), inflammation, education, physical activity, and smoking can damage DNA and shorten telomeres. Unpleasant conditions during pregnancy, including psychosocial risks, low socioeconomic status, no social support, any trauma during childhood, etc. contribute to an unfavorable intrauterine environment [6].

Therefore, a research gap is seen in the detection of telomeres in parents and their newborns in different SES. According to our previously published data [7, 8], it was found that there is a significant association between mother-newborn TL and SES. Moreover, there were smaller telomeres in mothers of low SES than in the upper middle

* Address correspondence to this author at the Department of Community Health Sciences, Aga Khan University, Karachi, Pakistan; E-mail: sadia.farrukh@aku.edu

and high SES. The telomere length was calculated as the ratio of telomere and single gene copy (T/S) ratio and base pairs. The research also highlighted that maternal blood (1.13 ± 0.18) had shorter telomeres than cord blood (1.18 ± 0.23) which confirmed genetic remodeling during fetal life [7]. Thus, association between telomere length and SES can contribute to health disparities and have lasting impacts on different socioeconomic groups in Pakistan. This study was designed to explore relationship linking parental and newborn telomere length (TL) among diverse socioeconomic populations, emphasizing programming during fetal life.

2. METHODOLOGY

This cross-sectional study enrolled 204 parents along with their newborns from Ziauddin Hospitals. Sample collection took place between September 2021 and July 2022 after obtaining approval from the Ziauddin University Ethics Review Committee under "Ref No. 3950721SFBC." The age of recruited parents were; mothers between 18 and 35 years and fathers between 18 and 45 years. Demographic data and socioeconomic status (SES) on participants' income basis were determined using the method described by Darin et al. [9].

Venous blood samples (5 ml) were collected from the mother, father, and umbilical cord immediately after delivery using ethylenediaminetetraacetic acid (EDTA) tubes. The samples were stored at 4°C. The DNA was extracted using the Qiagen DNA Blood Mini Kit (catalog No. 51306, Germany) and then stored at -80°C for further analysis. Leukocyte telomere length (TL) was quantified using real-time Polymerase Chain Reaction (qPCR) following established protocol [8, 10]. A pooled blood sample from four healthy males and females served as a reference DNA (standard) to create a standard curve for all qPCR runs. Quantification of telomere (T) and beta-globin gene (S) was performed using the Maxima Syber green master mix (catalog No. K0221 Thermo Scientific, USA) with DNA from the father and cord blood samples in triplicate. The telomere-to-beta-globin ratio (T/S ratio) was utilized to calculate leukocyte telomere length [8].

Data analysis was conducted using Statistical Package for Social Sciences (version 24). Descriptive statistics such as mean ± standard deviation (SD) for quantitative variables and frequency/percentages for qualitative variables were calculated. Graphs were generated using GraphPad Prism Software. The pooled t-test was employed to determine mean differences between parental and newborn TL, with a significance level set at $p < 0.05$ for all study data.

3. RESULTS

Among 204 mothers, 143 (70.1%) had the mean age range 25-35 and 56 (27.5%) were less than 25 years. Similarly, in fathers age distribution was 11(5.4%) were of <25 years, 114 (55.9) were 25-35 years and 79 (38.7%) were >35 years. Socioeconomic status showed equal distribution among both parents 51 (25%) except fathers of high and upper middle class (Table **1**).

Table 1: Demographics of parents of the study.

Study variables		Mother's N=204	Father's N=190
Age	<25	56(27.5)	11(5.4)
	25-35	143(70.1)	114(55.9)
	>35	5(2.5)	79(38.7)
Socioeconomic Status	Low	51(25)	51(25)
	Low Middle	51(25)	51(25)
	Upper Middle	51(25)	50(24)
	High	51(25)	52(26)

TL were compared among parents and newborns with regard to the socioeconomic status. Most of the comparison had significant differences with P-value< 0.05.

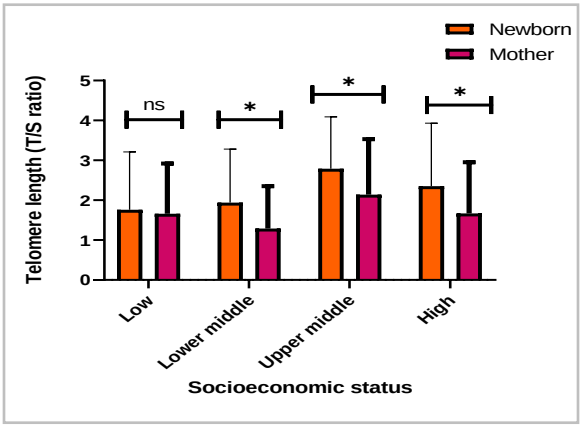

Figure 1: Mother-newborn TL (T/S ratio) among different socioeconomic status.

In Fig. (**1**) all the newborns had longest TL in all the SES. The smallest TL was seen among Low SES newborns (1.81 +1.07) whereas, longer TL was seen among upper middle SES newborn (2.7+1.30). Low SES group showed insignificant difference between (Newborn vs. mother).

Mothers of the upper middle SES showed longer TL (2.14+1.39) compared to other groups with significant results.

Among father newborns upper middle and high SES groups showed significant differences in TL (p=.001). Longer TL was seen in father-newborn of the upper middle group (2.69+1.37; 2.79+1.30) with significant difference (p=.001). There was a significant positive association (r=0.434, r=0.551) in upper middle and high SES between newborns and mothers (p=0.001). Whereas in fathers low, lower middle and high showed significant results (p=<0.05) (data not shown).

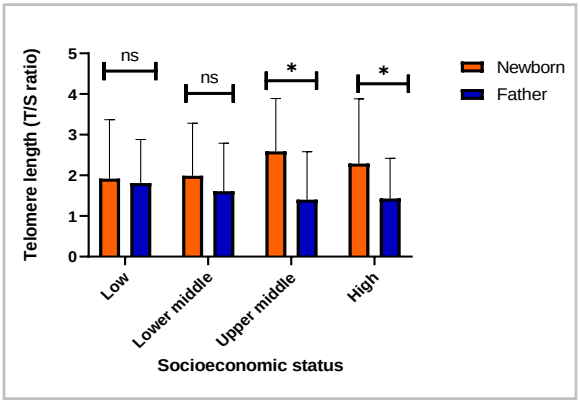

Figure 2: Father-newborn TL (T/S ratio) among different socioeconomic status.

4. DISCUSSION

This study, to the best of our knowledge, represents the first investigation into the telomere genetics and SES of parental-newborn. Notably, newborns from the upper-middle SES group exhibited longer TL (2.79 ± 1.30) compared to other SES groups, consistent with prior research [7]. However, contrasting results have been reported in other studies, showing either shorter or longer TL in relation to SES [11, 12].

The existing literature has identified a research gap concerning the connection between parental telomeres and demographic factors and their influence on newborns' telomere length (TL). Our study placed particular emphasis on socioeconomic status (SES) to investigate health disparities among parental and newborn TL. The findings revealed statistically significant results ($p < 0.05$) regarding the association between newborn TL and parental SES across all subgroups, including low, lower-middle, upper-middle, and high SES groups.

Furthermore, this study observed shorter TL in fathers from upper-middle and high SES groups compared to fathers with low SES, similar to findings from another study [13]. This could indicate a higher risk of developing ailments and early-onset diseases in the newborns to to fathers with shorter TL [14-16]. The association of SES with newborn TL and parental health may lead to DNA mutations, TL remodeling, or defects in genetic material repair during fetal life. The loss of telomeres and potential epigenetic modifications may stem from stresses experienced in both high and low SES environments [17].

In addition, our findings related to low socioeconomic status regarding early mortality and diseases age-related have also been reported by other studies [18]. Telomere alterations have been observed in young children facing various stressors such as infectious diseases, inadequate nutrition, or exposure to violence. These studies underscore childhood as a critical period for telomere degradation, serving as a marker of biological aging in middle and older ages [12]. Research has also indicated a decrease in telomere length across different cells and increased susceptibility to upper respiratory infections in individuals exposed to low SES during childhood and adolescence [14].

In summary, detecting telomere length at birth or in early life is significant due to its association with diseases and aging, which can originate early in life and persist into adulthood. Our findings regarding the association between parental SES and newborn TL may have important implications for later-life health outcomes. This was a single hospital sample study therefore it may not represent Pakistan's population, limiting generalizability. A limited sample size might account for some non-significant results. Additional research focusing on maternal health status and lifestyle factors could enhance data interpretation.

5. CONCLUSION

Newborns exhibited longer telomere length in comparison to their parents, indicating the phenomenon of in-utero reprogramming across all socioeconomic statuses. These findings underline the importance of addressing SES-related health disparities from early life.

CONFLICT OF INTEREST

The author declares that there is no conflict of interest.

FUNDING

This study was supported by the Higher Education Commission (HEC-NRPU) and Ziauddin University.

ACKNOWLEDGEMENTS

The author would like to acknowledge the colleagues, participants and the supporting staff in this study for their immense support.

REFERENCES

[1] Aslam HM, Alvi AA, Mughal A, Haq Z, Qureshi WA, Haseeb A, *et al*. Association of socioeconomic classes with diet, stress and hypertension. J Pak Med Assoc. 2013; 63(2): 289-94.

[2] Poverty & Equity Brief, Pakistan, South Asia April 2023. Available from: https://databankfiles. worldbank.org/public/ddpext_download/poverty/987B 9C90-CB9F-4D93-AE8C-750588BF00QA/current/ Global_POVEQ_PAK.pdf (accessed on April 1, 2024).
[3] Adler NE, Stewart J. Health disparities across the lifespan: meaning, methods, and mechanisms. Ann N Y Acad Sci. 2010; 1186(1): 5-23. https://doi.org/10.1111/j.1749-6632.2009.05337.x
[4] Blackburn EH, Epel ES, Lin J. Human telomere biology: a contributory and interactive factor in aging, disease risks, and protection. Science. 2015; 350(6265): 1193-8. https://doi.org/10.1126/ science.aab3389
[5] Zakian VA. Telomeres: the beginnings and ends of eukaryotic chromosomes. Exp Cell Res. 2012; 318(12): 1456-60. https://doi.org/10.1016/j.yexcr. 2012.02.015
[6] Schetter DC. Psychological science on pregnancy: stress processes, biopsychosocial models, and emerging research issues. Annu Rev Psychol. 2011; 62: 531-58. https://doi.org/10.1146/ annurev.psych.031809.130727
[7] Farrukh S, Baig S, Hussain R, Shahid A, Khan ST. Telomere reprogramming during fetal life in low socioeconomic mothers. Egypt J Med Hum Genet. 2019; 20(1): 1-10. https://doi.org/10.1186/s43042-019-0007-4
[8] Farrukh S, Baig S, Hussain R, Imad R, Khalid M. Parental genetics communicate with intrauterine environment to reprogram newborn telomeres and immunity. Cells. 2022; 11(23): 3777-7.
[9] Darin-Mattsson A, Fors S, Kåreholt I. Different indicators of socioeconomic status and their relative importance as determinants of health in old age. Int J Equity Health. 2017; 16(1): 173. https://doi.org/10.1186/s12939-017-0670-3
[10] Cawthon RM. Telomere length measurement by a novel monochrome multiplex quantitative PCR method. Nucleic Acids Res. 2009; 37(3): e21-1. https://doi.org/10.1093/nar/gkn1027
[11] Steptoe A, Hamer M, Butcher L, Lin J, Brydon L, Kivimäki M, et al. Educational attainment but not measures of current socioeconomic circumstances are associated with leukocyte telomere length in healthy older men and women. Brain Behav Immun. 2011; 25(7): 1292-8. https://doi.org/10.1016 /j.bbi.2011. 04.010
[12] Robertson T, Batty GD, Der G, Green MJ, McGlynn LM, McIntyre A, et al. Is telomere length socially patterned? evidence from the West of Scotland twenty-07 study. PLoS One. 2012; 7(7): e41805. https://doi.org/10.1371/journal.pone.0041805
[13] Needham BL, Straight B, Hilton CE, Olungah CO, Lin J. Family socioeconomic status and child telomere length among the Samburu of Kenya. Soc Sci Med. 2021; 283: 114182. https://doi.org/10.1016 /j. socscimed.2021.114182
[14] Cohen S, Janicki-Deverts D, Turner RB, Marsland AL, Casselbrant ML, Li-Korotky HS, et al. Childhood socioeconomic status, telomere length, and susceptibility to upper respiratory infection. Brain Behav Immun. 2013; 34: 31-8. https://doi.org/10.1016/j.bbi.2013.06.009
[15] Martens DS, Janssen BG, Bijnens EM, Clemente DBP, Vineis P, Plusquin M, et al. Association of parental socioeconomic status and newborn telomere length. JAMA Netw Open. 2020; 3(5): e204057. https://doi.org/10.1001/jamanetworkopen.2020.4057
[16] Khan RJ, Needham BL, Advani S, Brown K, Dagnall C, Xu R, et al. Association of childhood socioeconomic status with leukocyte telomere length among African Americans and the mediating role of behavioral and psychosocial factors: results from the GENE-FORECAST study. J Racial Ethn Health Disparities. 2022; 9(3): 1012-23. https://doi.org/10 .100 7/ s4 0615 -021-01040-5
[17] Entringer S, Epel ES, Kumsta R, Lin J, Hellhammer DH, Blackburn EH, et al. Stress exposure in intrauterine life is associated with shorter telomere length in young adulthood. Proc Natl Acad Sci USA. 2011; 108(33): E513-8. https://doi.org/10.1073/ pnas.1107759108
[18] Needham BL, Adler N, Gregorich S, Rehkopf D, Lin J, Blackburn EH, et al. Socioeconomic status, health behavior, and leukocyte telomere length in the National Health and Nutrition Examination Survey, 1999-2002. Soc Sci Med. 2013; 85: 1-8. https://doi.org/10.1016/j .socscimed. 2013.02.023

© 2024 *Sadia Farrukh*

This is an open access article licensed under the terms of the Creative Commons Attribution Non-Commercial License which permits unrestricted, non-commercial use, distribution and reproduction in any medium, provided the work is properly cited. (http://creativecommons.org/licenses/by-nc/4.0/)