Int J Endocrinol Metab. 2018 October; 16(4 (Suppl)):e84740. doi: 10.5812/ijem.84740.

Published online 2018 October 14. **Review Article**

The Impact of Physical Activity on Non-communicable Diseases: Findings from 20 Years of the Tehran Lipid and Glucose Study

Sara Sheikholeslami[1], Arash Ghanbarian[2,*] and Fereidoun Azizi[3]

[1]Cellular and Molecular Endocrine Research Center, Research Institute for Endocrine Sciences, Shahid Beheshti University of Medical Sciences, Tehran, Iran
[2]Prevention of Metabolic Disorders Research Center, Research Institute for Endocrine Sciences, Shahid Beheshti University of Medical Sciences, Tehran, Iran
[3]Endocrine Research Center, Research Institute for Endocrine Sciences, Shahid Beheshti University of Medical Sciences, Tehran, Iran

[*]*Corresponding author*: Prevention of Metabolic Disorders Research Center, Research Institute for Endocrine Sciences, Shahid Beheshti University of Medical Sciences, Tehran, Iran. Email: ghanbarian@endocrine.ac.ir

Received 2018 September 01; **Revised** 2018 October 02; **Accepted** 2018 October 07.

Abstract

Context: Low physical activity is one of the major risk factors for non-communicable diseases (NCD) such as cardiovascular disease and type 2 diabetes. The current paper reviews the main findings from Tehran lipid and glucose study (TLGS) that focus on physical activity and its association with cardiometabolic risk factors over the past two decades.
Evidence Acquisition: We conducted a literature search for articles from 1999 to December 2017 using the search terms: (Physical activity, leisure time physical activity, non-communicable disease, and TLGS).
Results: The prevalence of low physical activity was 69.8% during phase II of TLGS (2000 - 2004). During 6.5 years of follow up, the prevalence of low physical activity in the total population decreased significantly between phases II (2000 - 2004) and IV of TLGS (2008 - 2010) ($P < 0.05$). Overweight individuals with sedentary lifestyles had a higher risk of metabolic syndrome, compared to those who had high levels of leisure-time physical activity in phase IV of TLGS (2008 - 2010); in the obese group, systolic blood pressure, and triglyceride levels differed significantly between different leisure-time physical activity categories (106.9 ± 14.3 vs. 119.1 ± 17.2 mmHg, $P = 0.03$) and (111.4 ± 1.6 vs. 147.1 ± 1.6 mg/dL, $P = 0.01$), respectively.
Conclusions: The present review highlights the impact of low physical activity on the health of the TLGS community from adolescence to adulthood. The decreased prevalence of low physical activity from phase II to phase IV of TLGS indicates the necessity for lifestyle interventions as a potentially effective strategy, which could have a positive impact on various risk factors and indicators of non-communicable diseases such as body mass index, waist circumference, systolic blood pressure, and lipid profiles.

Keywords: Low Physical Activity, Leisure-Time Physical Activity, Metabolic Syndrome, TLGS

1. Context

Low physical activity is one of the main risk factors for non-communicable diseases (NCDs) such as cardiovascular disease and type 2 diabetes (1, 2). The World Health Organization (WHO) reports that low physical activity causes 27% of diabetes and 20% of ischemic heart disease and it is one of the eight main risk factors of cardiovascular deaths, and, more importantly, is one of the five global risks for mortality (3). The health-care costs of low physical activity were estimated at $53.8 billion, including $5.0 billion for coronary heart disease and $37.5 billion for type 2 diabetes in 2013. Low physical activity is responsible for $2.4 billion health-care costs in the Eastern Mediterranean regions, with Iran's share estimated at $609,296 (4).

The Tehran lipid and glucose study (TLGS), a population-based study, has been designed with the aim of determining and preventing the risk factors for NCDs through changing lifestyles of the population since 1999. This study consists of two major components: Phase I is a cross-sectional prevalence study of NCDs and associated risk factors and phase II to VI are prospective interventional studies with repeated data collection every 3 years (5, 6). Data on TLGS physical activity was obtained using two questionnaires, the lipid research clinic (LRC) and modifiable activity questionnaire (MAQ). In addition, some efforts have been made to increase the rate of physical activity in the intervention phase of TLGS survey. These included; (1) face to face training, (2) physical activity training and emphasizing the importance of the sport education times in schools, (3) providing some facilities such as free or half-price vouchers for TLGS participants. The current paper hence reviews the main results of the studies investigating physical activity levels in the TLGS population.

2. Evidence Acquisition

We conducted a literature search for articles published between 1999 to December 2017 using the search terms: "physical activity", "leisure time physical activity", "non-communicable disease", and "TLGS" in PubMed database. Seventeen articles were found. During 20 years of TLGS, the impact of physical activity has been investigated in two forms; (1) as an independent and main risk factor for NCDs (2) as a dependent risk factor or confounder factor for other variables. Because of the importance of the first item and the extension of the second item, the current paper reviews the main results of the studies which targeted physical activity as the main risk factor in TLGS population.

Physical activity data were collected by two methods; LRC was used in initial phase of TLGS (phase I) and is a simple measure including four questions. Since the data obtained through LRC were rather subjective and not accurate for the Iranian culture, the physical activity questionnaire was replaced by a Persian-translated MAQ questioner, which measures leisure-time, job, and household activities and calculates the metabolic equivalent (MET) based on min/wk. 1500 min/wk) (7). The physical activity levels has been defined as low (MET < 600 min/wk), moderate (MET 600 - 1499 min/wk) and high (MET ≥ 1500 min/wk) levels (8). Momenan et al. have previously determined the reliability (98%) and validity (47%) of the Persian MAQ version (9). Leisure-time physical activity specifies performing three or more days of vigorous-intensity activity of at least 20 minutes, or five or more days of moderate-intensity activity or walking for at least 30 minutes or ≥ 5 days of any combinations of walking, moderate, and vigorous activity.

3. Results

3.1. The Prevalence of Leisure-Time Physical Activity/Inactivity

3.1.1. Adults

Low physical activity as the health levels in our society are increasingly dangerously. According to the TLGS study, during 2000 - 2004 (phase II of TLGS), the prevalence of leisure-time low physical activity was 69.8% and the prevalence of physical activity was 30% for both genders, among total TLGS population (n = 72850). The levels of leisure-time physical activity of 1590 men (50.6%) and 1803 women (43.5%) were less than 30 min/week. As expected, the prevalence of inactivity increased as BMI increased (69.8% in overweight men and 75.3% in obese men; P < 0.05). In addition, low physical activity level in occasional smokers was 36% higher than in never smokers (P = 0.002) (10). Another study in TLGS participants with no history of lifestyle intervention during the phase II (3515 TLGS adults), showed a significant decrease in leisure-time physical activity among women (P < 0.05), after a 6.5-year follow up. The prevalence of low physical activity in this study decreased significantly between phases II and IV of TLGS, (45.9% vs. 42.6%, P < 0.05), especially among older men (≥ 60 year). Eventually, results indicated a 3.3% decrease in the prevalence of low physical activity during a 6.5 year follow up (11). Although a decrease in low physical activity has been observed, it's prevalence still remains high.

3.1.2. Adolescents

Physical activity undoubtedly is related to the obesity status of adolescents (12). Published TLGS data reveal that, among 777 adolescents participants, 50.4% of individuals with normal weight and 44% of overweight/obese adolescents (BMI ≥ 85th percentile) had high levels of physical activity (≥ 6 MET of intensity), levels which were 0.8 ± 0.4 and 0.6 ± 0.2 h/day in the normal weight and overweight/obese groups, respectively, indicating that most of the TLGS adolescents have moderate and high physical activity (13).

3.2. Physical Activity and Metabolic Syndrome

The physical activity and the components of metabolic syndrome (MetS), i.e. waist circumference (WC), fasting blood glucose (FBG), Triglycerides (TG), high density lipoprotein-cholesterol (HDL-C), systolic blood pressure (SBP), diastolic blood pressure (DBP), have been investigated in the TLGS population and have been known to be associated with each other; means of mentioned variables were significantly higher in the overweight/obese adolescents, except for HDL-C and FBG in each tertile of physical activity. In normal weight individuals, there was a significant association between light physical activity and the risk of lower levels of HDL-C (P: 0.01). Overweight/obese subjects with light and moderate physical activity levels had larger WC than those who participated in vigorous physical activity, only after adjustment for determined confounders (OR = 1.11; CI 95% 1.07, 1.21; P: 0.01) (OR = 1.06; CI 95% 1.01, 1.08; 0.02, respectively) (13). Data from 5568 (2486 male, 3082 female) non-diabetic participants aged ≥ 20 years in TLGS (phase IV, 2008 - 2010) shows that in both genders, the most pre-diabetic patients were not active in leisure-time physical activity, compared to non-prediabetic controls (P < 0.01). Prediabetic male participants had indirect association with both poor diet and physical activity, via BMI and TG, respectively, prediabetic female participants. Whereas these association has been between behavioral factors and pre-diabetes were via TG, respectively in prediab. Leisure-time physical activity and poor diet were significantly correlated, only in men (P <

0.01) (14). Higher risk of MetS was detected in Overweight people with a sedentary lifestyle compared to who had high leisure-time physical activity levels in phase IV of TLGS (15). In brief, results of these studies showed the impact of physical activity on MetS components and some MetS component review as below:

3.2.1. Hypertension

In the obese group, SBP differed significantly by leisure-time physical activity categories (106.9 ± 14.3 mmHg vs. 119.1 ± 17.2 mmHg, P = 0.03). Normal-weight participants with high leisure-time physical activity had a greater risk of high SBP than did those who had leisure-time physical activity moderately (OR, 0.52; 95% CI, 0.31 - 0.86; P = 0.01), the similar risk was detected in obese people whit vigorous leisure-time physical activity, compared to those who had light leisure-time physical activity (OR, 0.60; 95% CI, 0.41 - 0.91; P = 0.01) and moderate leisure-time physical activity (OR: 0.58; 95% CI, 0.39 - 0.64; P = 0.005) (15).

3.2.2. Dyslipidemia

In the obese group, TGs levels differed significantly by leisure-time physical activity categories (111.4 ± 1.6 mg/dL vs. 147.1 ± 1.6 mg/dL, P = 0.01). (15). Normal-weight adults who participated in light leisure-time physical activity had a higher risk of elevated triglycerides and reduced HDL-C, than did adults who participated in vigorous leisure-time physical activity (OR, 1.46; 95%; CI, 1.01 - 2.14; P = 0.049) (OR, 1.15; 95% CI, 1.05 - 2.33; P = 0.03); hence the results demonstrated that for the normal-weight group with a sedentary lifestyle, the risk of having higher triglyceride levels was 46% and in those with lower HDL-C was 15% higher than for those with vigorous leisure-time physical activity (15).

3.2.3. Dysglycemia

In the overweight group, adults who participated in moderate leisure-time physical activity had higher FBG levels than those with vigorous leisure-time physical activity after adjustment for sex, age, smoking status, education levels, and calorie intake (OR, 1.65; 95% CI, 1.37 - 3.23; P = 0.02); the association between MetS and light leisure-time physical activity was significant only after adjustment for those variables (OR, 2.08; 95% CI, 1.03 - 4.21; P = 0.04). Overweight individuals with vigorous leisure-time physical activity had lower FBG than groups with moderate leisure-time physical activity (15).

3.3. Low Physical Activity and Obesity

Logistic regression analyses of 7285 adults in phase II of TLGS, revealed that rates of low physical activity of men with BMI > 30 kg/m^2 were significantly higher than the rates of physical activity of men with BMI < 25 kg/m^2 (P = 0.001). There was no significant difference between the BMI 25 - 30 kg/m^2 group and the reference group in men (10). On the other hand, another study showed no significant difference between BMI groups regarding leisure-time physical activity categories during phase III of TLGS (2005 - 2008) (15). Analysis of different TLGS phases yielded different results on the association between physical activity and obesity.

Mother's physical activity could affected the prevalence of children obesity with mean ages of 5.3 and 9.1 year. Across quartiles of mother's physical activity, from heavy to light, the prevalence of obesity increased among children, from 4.4% to 5.9% in children, aged 5.3 year (P = 0.02) and from 11.6% to 13.0% in children, aged 9.1 year (P = 0.03). The father's physical activity had little effect on the prevalence of children obesity (mean age 5.3 year) (12). hence apparently parent's physical activity and physical activity at any age could have an impact on body weight and obesity.

3.4. Social and Behavioral Factors

Two TLGS study have focused on physical activity as a dependent factor and aimed assessment of the effect of the social and behavioral factors on physical activity. Among 7285 TLGS participants in phase II, there was no statistically significant difference between the prevalence of low physical activity based on age, smoking, educational levels and hours worked; the prevalence of inactivity only increased with age from 20 to 49 in men (P = 0.001) (10). In another survey, the assessment of a conceptual model of associations between socio-demographic, behavioral factors and obesity showed that in both genders, being employed and having lower levels of education significantly lowered leisure-time physical activity in phase IV of TLGS (P < 0.01), and also, men are married had significantly lower leisure-time physical activity (P < 0.01) (16); these results are not sufficient and for these studies on study the association between social and behavioral factors and physical activity are needed.

4. Discussion

The present review indicates the impacts of low physical activity on the health of the community from adolescence to adulthood. The prevalence of low physical activity among adults was 69.8% and a significant increase in physical activity was documented in a 6.5-years follow up. A Brazilian study showed 66.6% low physical activity in adults, data is almost as same as very similar to our results (17). The significant increase in physical activity was also observed from 1999 to 2009 in Switzerland (18). It needs to be mentioned that the questionnaires used were different.

Our results revealed that physical activity is associated with some of the MetS components in both adolescents and adults, results consistent with other studies that revealed moderate and high physical activity is related with lower risk of MetS in adolescents (8) and adults (19). It is obvious that low physical activity during childhood and adolescence could affect adult low physical activity and increase non-communicable disease risk factors such as BMI, high blood pressure in the future (20, 21). Based on our results, physical activity interventions could be an effective strategy and have a positive impact on reducing the components of non-communicable diseases such as BMI, WC, and SBP not only in adolescence, but also in adulthood. Public health efforts must be increased to improve the physical activity levels to prevent the non-communicable diseases and other related diseases.

TLGS studies focusing on physical activity, of course, do have some limitations; first, the prevalence of physical activity was not assessed in children; second, the data are obtained based on self-report questioners and study outcomes may hence have recall bias; third, because of using different physical activity questionnaires and methods from other studies, any generalization of this study to others could be problematic; fourth, there is much physical activity data that has not been released yet, and hence many gaps in data available. Future studies are hence needed to determine the prevalence of all TLGS phases from childhood to adulthood, and to identify clinical aspects of physical activity. Interventions for physical activity, of course must be continued in TLGS population.

4.1. Conclusion

The present review highlights the impact of low physical activity on the health of the TLGS community from adolescence to adulthood. The decreased prevalence of low physical activity from phase II to phase IV of TLGS indicates the necessity for lifestyle interventions as a potentially effective strategy, which could have a positive impact on various risk factors and indicators of non-communicable diseases such as BMI, WC, SBP, and lipid profiles.

Acknowledgments

The authors wish to acknowledge Dr. Miralireza Takyar for scientific editing and Ms. Niloofar shiva for critical editing of English grammar and syntax of the manuscript. The authors would also like to show our gratitude to the TLGS staff and participants for their contribution.

References

1. Lee IM, Shiroma EJ, Lobelo F, Puska P, Blair SN, Katzmarzyk PT, et al. Effect of physical inactivity on major non-communicable diseases worldwide: An analysis of burden of disease and life expectancy. *Lancet*. 2012;**380**(9838):219–29. doi: 10.1016/S0140-6736(12)61031-9. [PubMed: 22818936]. [PubMed Central: PMC3645500].
2. Eckert S, Kohler S. Urbanization and health in developing countries: A systematic review. *World Health Popul*. 2014;**15**(1):7–20. doi: 10.12927/whp.2014.23722. [PubMed: 24702762].
3. World Health Organization. *Global health risks: Mortality and burden of disease attributable to selected major risks*. Geneva: World Health Organization; 2009.
4. Ding D, Lawson KD, Kolbe-Alexander TL, Finkelstein EA, Katzmarzyk PT, van Mechelen W, et al. The economic burden of physical inactivity: A global analysis of major non-communicable diseases. *Lancet*. 2016;**388**(10051):1311–24. doi: 10.1016/S0140-6736(16)30383-X. [PubMed: 27475266].
5. Azizi F, Rahmani M, Emami H, Mirmiran P, Hajipour R, Madjid M, et al. Cardiovascular risk factors in an Iranian urban population: Tehran lipid and glucose study (phase 1). *Soz Praventivmed*. 2002;**47**(6):408–26. doi: 10.1007/s000380200008. [PubMed: 12643001].
6. Azizi F, Ghanbarian A, Momenan AA, Hadaegh F, Mirmiran P, Hedayati M, et al. Prevention of non-communicable disease in a population in nutrition transition: Tehran lipid and glucose study phase II. *Trials*. 2009;**10**:5. doi: 10.1186/1745-6215-10-5. [PubMed: 19166627]. [PubMed Central: PMC2656492].
7. Pereira MA, FitzerGerald SJ, Gregg EW, Joswiak ML, Ryan WJ, Suminski RR, et al. A collection of physical activity questionnaires for health-related research. *Med Sci Sports Exerc*. 1997;**29**(6 Suppl):S1–205. [PubMed: 9243481].
8. Ainsworth BE, Jacobs DR, Jr, Leon AS. Validity and reliability of self-reported physical activity status: The Lipid Research Clinics questionnaire. *Med Sci Sports Exerc*. 1993;**25**(1):92–8. doi: 10.1249/00005768-199301000-00013. [PubMed: 8423761].
9. Momenan AA, Delshad M, Sarbazi N, Rezaei Ghaleh N, Ghanbarian A, Azizi F. Reliability and validity of the modifiable activity questionnaire (MAQ) in an Iranian urban adult population. *Arch Iran Med*. 2012;**15**(5):279–82. [PubMed: 22519376].
10. Momenan AA, Delshad M, Mirmiran P, Ghanbarian A, Azizi F. Leisure time physical activity and its determinants among adults in Tehran: Tehran lipid and glucose study. *Int J Prev Med*. 2011;**2**(4):243–51. [PubMed: 22174964]. [PubMed Central: PMC3237267].
11. Afghan M, Ghasemi A, Azizi F. Seven-year changes of leisure-time and occupational physical activity among iranian adults (Tehran lipid and glucose study). *Iran J Public Health*. 2016;**45**(1):41–7. [PubMed: 27057520]. [PubMed Central: PMC4822392].
12. Mottaghi A, Mirmiran P, Pourvali K, Tahmasbpour Z, Azizi F. Incidence and prevalence of childhood obesity in Tehran, Iran in 2011. *Iran J Public Health*. 2017;**46**(10):1395–403. [PubMed: 29308384]. [PubMed Central: PMC5750352].
13. Fam B, Amouzegar A, Arzhan S, Ghanbariyan A, Delshad M, Hosseinpanah F, et al. Association between physical activity and metabolic risk factors in adolescents: Tehran lipid and glucose study. *Int J Prev Med*. 2013;**4**(9):1011–7. [PubMed: 24130941]. [PubMed Central: PMC3793481].
14. Amiri P, Jalali-Farahani S, Karimi M, Taherian R, Kazempour-Ardebili S, Hosseini-Esfahani F, et al. Factors associated with pre-diabetes in Tehranian men and women: A structural equations modeling. *PLoS One*. 2017;**12**(12). e0188898. doi: 10.1371/journal.pone.0188898. [PubMed: 29216229]. [PubMed Central: PMC5720750].
15. Faam B, Hosseinpanah F, Amouzegar A, Ghanbarian A, Asghari G, Azizi F. Leisure-time physical activity and its association with metabolic risk factors in Iranian adults: Tehran lipid and glucose study, 2005-2008. *Prev Chronic Dis*. 2013;**10**. E36. doi: 10.5888/pcd10.120194. [PubMed: 23489641]. [PubMed Central: PMC3600871].

16. Jalali-Farahani S, Amiri P, Karimi M, Gharibzadeh S, Mirmiran P, Azizi F. Socio-behavioral factors associated with overweight and central obesity in Tehranian adults: A structural equation model. *Int J Behav Med*. 2017;**24**(1):110–9. doi: 10.1007/s12529-016-9574-7. [PubMed: 27272681].
17. Madeira MC, Siqueira FC, Facchini LA, Silveira DS, Tomasi E, Thume E, et al. [Physical activity during commuting by adults and elderly in Brazil: Prevalence and associated factors]. *Cad Saude Publica*. 2013;**29**(1):165–74. Portuguese. [PubMed: 23370036].
18. Guessous I, Gaspoz JM, Theler JM, Kayser B. Eleven-year physical activity trends in a Swiss urban area. *Prev Med*. 2014;**59**:25–30. doi: 10.1016/j.ypmed.2013.11.005. [PubMed: 24252488].
19. Ekelund U, Anderssen S, Andersen LB, Riddoch CJ, Sardinha LB, Luan J, et al. Prevalence and correlates of the metabolic syndrome in a population-based sample of European youth. *Am J Clin Nutr*. 2009;**89**(1):90–6. doi: 10.3945/ajcn.2008.26649. [PubMed: 19056570].
20. Huotari P, Nupponen H, Mikkelsson L, Laakso L, Kujala U. Adolescent physical fitness and activity as predictors of adulthood activity. *J Sports Sci*. 2011;**29**(11):1135–41. doi: 10.1080/02640414.2011.585166. [PubMed: 21777154].
21. Chen X, Wang Y. Tracking of blood pressure from childhood to adulthood: A systematic review and meta-regression analysis. *Circulation*. 2008;**117**(25):3171–80. doi: 10.1161/CIRCULATIONAHA.107.730366. [PubMed: 18559702]. [PubMed Central: PMC3568631].