

## A Study on the Relationship Between Sleep Time and HbA1c in Korean Adult Female

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### Abstract

*This study aimed to determine the relationship between glycated hemoglobin and sleep time in each age group of Korean females. The candidates' study subjects were 16,277 females from the 7th National Health and Nutrition Survey (2016-2017), and raw data from 6,266 females were included in the final analysis. For the analysis, complex sample chi-square test, General Linear Model (GLM), and complex sample logistic model were performed. Results: The sleep time showed a statistically significant difference in the adolescent and middle-aged groups. However, this significance survived only in the middle-aged group after applying covariates, indicating that longer sleep time is associated with a higher risk of diabetes mellitus. It is expected that, based on these results, sleep time and glycated hemoglobin will be monitored to screen for diabetes mellitus complications and other various health problems.*

**Keywords:** Sleep, Diabetes mellitus, Glycated hemoglobins, Adult, National health and nutrition survey

## 1. Introduction

### 1.1. Background

The development of industrial technology and civilization in complex modern societies has greatly influenced the sleep patterns of humans, resulting in an increased prevalence of diabetes [1]. Even though the American National Sleep Foundation recently recommended the appropriate sleeping time of adults as 7-9 hours a day [2], sleep deprivation is a common condition in modern society and an issue in the field of public health [3]. In the Korean population, in particular, sleeping time is short, as evidenced by sleeping time of fewer than 6.5 hours is 50% of the general population. The ratio of respondents who did not have sleeping problems for the past month was only 14%, and the quality of sleep was also poor [4]. The prevalence of diabetes, accordingly, is increasing steadily.

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#### Article history:

Received (March 27, 2019), Review Result (April 28, 2019), Accepted (May 29, 2019)

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The number of patients with diabetes has increased from about 320 million in 2014 to 425 million in 2017 worldwide, and over four million people died in 2017 due to diabetes and associated complications. It is expected that, based on this rapid trend, patients with diabetes will reach 693 million in 2045 and become serious social problems.

This trend is also observed in Korea; according to the report by the Korean Diabetes Association in 2018, the prevalence of diabetes mellitus was 15.% in men and 13% in women over 30 years old, and this disease was the fifth leading cause of death.

It was reported that sleep deprivation and other sleep problems are associated with various cardio-cerebrovascular diseases such as hypertension, diabetes, and obesity. A small number of previous studies, in addition, have suggested that sleeping time is associated with diabetes and that sleep affects diabetes mellitus, which accounts for the majority of deaths [5].

In Korean studies, personal factors such as sex and age have been reported to be associated with sleep time and glycated hemoglobin. Kim showed that sleep and diabetes are unrelated and need further research. For the studies in another country, Hiromi Nakajima, who observed a change in insulin sensitivity of 20 American male subjects while limiting their sleep time to under five hours a day, reported that insulin sensitivity decreased. Despite these results of previous studies, only some studies have analyzed the relationship between sleep time and glycated hemoglobin. Therefore, this study's purpose was to provide essential data for preventing and managing diabetes mellitus by investigating the influencing factors of glycated hemoglobin in Korean adult females from adolescents (early adults) to the elderly based on the Life Cycle Theory of Erikson, a German psychologist. For this purpose, the relationship between sleep time and glycated hemoglobin of each age group in three groups, regular group (NG), impaired fasting glucose group (IFGG), and diabetic group (DG), based on data from the 7th National Health and Nutrition Survey (2016-2017).

## 1.2. Purpose

This study aimed to determine the effect of sleep on glycated hemoglobin and provide essential data for the prevention and management of diabetes mellitus by investigating the influencing factors of the relationship between sleep time and glycated hemoglobin in Korean adult females.

The specific purposes are as follows:

- To investigate the diabetes mellitus distribution in each age group.
- To analyze the difference in glycated hemoglobin and diabetes mellitus according to each age group's general and health-related characteristics.
- To determine whether sleep time affects glycated hemoglobin and diabetes mellitus in each age group.

## 1.3. Definition

### (1) Sleep

Sleep is used to restore the motivation for the activity by recovering from physical and mental fatigue. The required sleep time depends on the age, and securing such time is essential in promoting the treatment of disease [6].

### (2) Diabetes mellitus

The criteria for diagnosing diabetes mellitus include glycated hemoglobin  $\geq 6.5\%$ , 8 hours fasting plasma glucose  $\geq 126$ /dL, plasma glucose two hours after oral glucose tolerance test  $\geq 200$  mg/dL, and typical symptoms of diabetes (polydipsia, polyuria), among which, most

widely used one in diagnosing and management of diabetes mellitus and predicting complications is glycated hemoglobin.

(3) Glycated Hemoglobin

The glycation in glycated hemoglobin (Hemoglobin A1c, HbA1c) means the nonenzymatic addition of sugar residue into the amino group of proteins. The test is available regardless of fasting. This value shows a comprehensive 8-12-week glucose status and, thus, has been used as an essential indicator in long-term blood glucose control.

**2. Method**

**2.1. Design**

This second analysis study was to investigate the relationship between sleep and glycated hemoglobin in adults and acquired permission to use raw data from the 7th National Health and Nutrition Survey (2016-2017) hosted by the Korean Centers for Disease Control and Prevention.

**2.2. Subjects and analysis**

The candidate's study subjects were 6,599 females over 12 years old from 16,277 participants of the 7th National Health and Nutrition Survey (2016-2017). This study performed complex sample analysis by applying new integrated weights generated from integrating strata for variation prediction (kstrata), survey district (psu), and 7th wave (2016-2017) data.

The analysis for each age group of adolescents, adults, middle-aged, and elderly. The chi-square test was performed, and a general linear model was applied to investigate each group's general characteristics and distribution (NG, IFGG, and DG) by analyzing the relationship between socio-demographic variables and health-related ones. The risk of diabetes mellitus was determined by applying a complex sample logistic model adjusted by socio-demographic and health-related variables.

**2.3. Results**

**2.3.1. Glycated hemoglobin and diabetes mellitus profile by age groups**

The proportion of subjects diagnosed with diabetes mellitus was 0.5% in adolescents, 0.8% in adults, 9.2% in middle-aged, and 6.1% in the elderly, showing an increasing trend by age.

Table 1. Diabetic mellitus profile by age groups

| Groups: Age                                     | NG         | IFGG       | DG        | Total     |
|---|------------|------------|-----------|-----------|
| Adolescent (Early adult): 12-19                 | 444(93.9)  | 30(5.6)    | 1(0.5)    | 475(100)  |
| Adult: 20-39                                    | 1446(91.3) | 149(7.9)   | 16(0.8)   | 1611(100) |
| Middle-aged: 40-59                              | 2094(69.9) | 655(20.9)  | 278(9.2)  | 3027(100) |
| Elderly: over 60                                | 685(46.1)  | 419(27.8)  | 382(26.1) | 1486(100) |
| Total   | 4669(74.5) | 1253(16.9) | 677(8.7)  | 6599(100) |
| Rau-Scott $\chi^2=680.284$ , $df=6$ , $p<.0001$ |            |            |           |           |

The proportions of impaired fasting glucose were also 5.6%, 7.9%, 20.9%, and 27.8%, respectively, and increased by age.

Table 2. Socio-demographic and health-related factors by diabetes Miletus groups

|                                |            | Adolescent |                | Adult      |               | Middle-aged |               | Elderly    |               |
|--------------------------------|------------|------------|----------------|------------|---------------|-------------|---------------|------------|---------------|
|                                |            | Odds ratio | (95% C.I.)     | Odds ratio | (95% C.I.)    | Odds ratio  | (95% C.I.)    | Odds ratio | (95% C.I.)    |
| Age                            |            | 1.019      | (0.727-1.428)  | 1.072      | (1.013-1.135) | 0.979       | (0.96-0.999)  | 0.966      | (0.931-1.002) |
| Education Level                | Elementary |            |                | 1          |               | 1           |               | 1          |               |
|                                | Middle     |            |                | 0.056      | (0.006-0.559) | 1.45        | (0.941-2.235) | 1          | (0.514-1.948) |
|                                | High       |            |                | 0.087      | (0.009-0.844) | 1.037       | (0.695-1.548) | 1.366      | (0.798-2.338) |
|                                | Collage    |            |                | 0.076      | (0.005-1.095) | 1.156       | (0.735-1.819) | 0.789      | (0.506-1.232) |
| Marital Status                 | Yae        |            |                | 1          |               | 1           |               | 1          |               |
|                                | No         |            |                | 0.897      | (0.459-1.751) | 1.788       | (0.852-3.753) | 1.269      | (0.26-6.192)  |
| Waist Circumference            |            | 1.106      | (1.044-1.172)  | 1.077      | (1.05-1.104)  | 0.931       | (0.919-0.944) | 0.949      | (0.929-0.969) |
| Smoking                        | No         |            |                | 1          |               | 1           |               | 1          |               |
|                                | Every day  |            |                | 1.258      | (0.563-2.813) | 0.715       | (0.41-1.247)  | 1.005      | (0.394-2.562) |
|                                | Sometime   |            |                | 1.244      | (0.324-4.776) | 0.888       | (0.351-2.249) | 0.209      | (0.011-3.912) |
|                                | Exsmoker   |            |                | 0.541      | (0.179-1.632) | 0.945       | (0.42-2.124)  | 0.494      | (0.129-1.893) |
| Income                         | No         |            |                | 1          |               | 1           |               | 1          |               |
|                                | Medium     | 1.121      | (0.185-6.797)  | 1.25       | (0.441-3.545) | 1.434       | (0.954-2.156) | 1.185      | (0.633-2.219) |
|                                | Slander    | 0.808      | (0.118-5.546)  | 1.379      | (0.505-3.764) | 1.448       | (0.976-2.15)  | 0.721      | (0.437-1.19)  |
|                                | Prize      | 1.659      | (0.269-10.212) | 1.145      | (0.403-3.25)  | 1.622       | (1.067-2.465) | 1.19       | (0.748-1.894) |
| Drinking                       | No         |            |                | 1          |               | 1           |               | 1          |               |
|                                | <1/month   |            |                | 0.892      | (0.244-3.264) | 1.452       | (0.648-3.254) | 0.778      | (0.197-3.071) |
|                                | 1/month    |            |                | 1.273      | (0.561-2.889) | 1.367       | (0.898-2.081) | 0.781      | (0.263-2.319) |
|                                | 2~3/month  |            |                | 1.487      | (0.736-3.005) | 1.192       | (0.846-1.678) | 0.873      | (0.473-1.61)  |
|                                | 2~3/week   |            |                | 1.192      | (0.498-2.852) | 1.086       | (0.713-1.654) | 1.081      | (0.596-1.959) |
|                                | >4/week    |            |                | 1.159      | (0.572-2.348) | 1.218       | (0.882-1.682) | 1.043      | (0.676-1.609) |
| Stress                         |            | 1.235      | (0.5-3.047)    | 1.273      | (0.897-1.807) | 1.051       | (0.878-1.258) | 1.038      | (0.831-1.298) |
| Physical activity (minute/day) |            | 0.999      | (0.997-1.002)  | 1          | (1-1.001)     | 1           | (0.999-1)     | 1          | (1-1.001)     |
| Family History                 | No         | 1          |                | 1          |               | 1           |               | 1          |               |
|                                | Yes        | 3.018      | (0.464-19.62)  | 1.806      | (1.074-3.038) | 0.542       | (0.432-0.68)  | 0.374      | (0.247-0.566) |
| Hypotension                    | No         |            |                |            |               | 1           |               | 1          |               |

|            |              |       |                |       |               |       |               |       |               |
|------------|--------------|-------|----------------|-------|---------------|-------|---------------|-------|---------------|
|            | Yes          |       |                |       |               | 0.567 | (0.409-0.785) | 0.579 | (0.395-0.849) |
| Sleep time | <6hr         |       |                |       |               |       |               |       |               |
|            | <7hr         | 5.318 | (0.945-29.921) | 1.14  | (0.491-2.648) | 1.562 | (1.121-2.177) | 0.788 | (0.505-1.228) |
|            | <8hr         | 0.936 | (0.11-7.99)    | 1.172 | (0.519-2.648) | 1.512 | (1.091-2.094) | 1.059 | (0.66-1.701)  |
|            | >8hr         | 1.28  | (0.163-10.068) | 1.017 | (0.414-2.499) | 1.532 | (1.077-2.179) | 0.77  | (0.467-1.268) |
|            | P trend test |       | .153           |       | .664          |       | .023          |       | .544          |

*Covariate: Adolescent - Age, Education level, Income, Stress, Physical Activity, Family history  
 Adult - Age, Education level, Marital status, Smoking, Income, Drinking, Stress, Physical Activity, Family history  
 Middle-aged, Elderly - Age, Education level, Marital status, Smoking, Income, Alcohol, Stress, Physical Activity, Family history*

**2.3.2. analysis of socio-demographic and health-related factors on glyated hemoglobin and diabetes mellitus groups by age groups**

The results of the analysis to determine whether there is a difference in diabetes mellitus by age groups showed that there was a statistically significant difference in family history (p=.008) and sleep time (p=.030) in adolescents and family history (p<.001), an education level (p<.001), marital status (p<.001), and waist circumference (p<.001) in adults.

The statistically significant differences were also observed in family history (p<.001), sleep time (p=.011), education level (p<.001), income (p<.001), drinking (p=.006), and stress (p=.003) in middle-aged and in family history (p<.001), physical activity (p=.004), and waist circumference (p<.001).

**2.3.3. The influence of sleep time on glyated hemoglobin and diabetes mellitus**

The influence of sleep time on glyated hemoglobin and diabetes mellitus was analyzed by age group.

The results showed that, in adolescents, the waist circumference (OR=1.106) was statistically significant, and the OR of 7-8 hours of sleep time was low but did not reach statistical significance. In the adults, the waist circumference (OR=1.077) and family history (OR=1.806) were statistically significant, and the OR of 7-8 hours of sleep time was highest but did not reach statistical significance. In the middle-aged, the highest income level showed the highest OR (1.622) and statistical significance, and waist circumference (OR=0.931), family history (OR=0.542), and hypotension (OR=0.567) showed statistical significance. For the sleep time, 6-7 hours (OR=1.562), 7-8 hours (OR=1.512), and 8 hours (OR=1.532) of sleep time showed higher OR compared to less than six hours of sleep time, and this difference was statistically significant. In the elderly, the waist circumference (OR=0.949), family history (OR=0.347), and hypotension (OR=0.579) showed statistical significance and 7-8 hours of sleep time showed higher OR and 6-7 hours and more than 8 hours showed lower OR, however, these differences were not statistically significant.

**3. Conclusion**

The prevalence of diabetes mellitus was highest in the elderly group (26.1%), and that of impaired fasting glucose was also highest in this group (27.8%). The influencing factors of glyated hemoglobin and diabetes mellitus were family history in all age groups, excluding adolescents, waist circumference in all age groups, lower income, shorter sleep time, hypertension in the middle-aged group, and hypotension in the elderly group. It is

recommended that an intervention program be developed to identify the population vulnerable to glycated hemoglobin early and contribute to lowering the glycated hemoglobin with age-fitted strategies.

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