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ARTICLE

# ASSESSMENT OF ORAL HEALTH STATUS AND ITS ASSOCIATION WITH ORAL HYGIENE PRACTICES AND ORAL HEALTH-RELATED QUALITY OF LIFE AMONG BEEDI FACTORY WORKERS IN SOUTHERN DISTRICTS OF TAMIL NADU: A CROSS-SECTIONAL STUDY

## Evaluación del estado de salud bucodental y su asociación con las prácticas de higiene bucal y la calidad de vida relacionada con la salud bucodental en trabajadores de fábricas de beedis de los distritos del sur de Tamil Nadu: un estudio transversal

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## ABSTRACT

**Aim:** This study aims to assess the oral health status, oral hygiene practices and Oral Health Related Quality of Life among Beedi workers in the southern districts of Tamil Nadu.

**Material and Methods:** A cross-sectional study was conducted among beedi factory workers in the southern districts of Tirunelveli, Theni, and Tenkasi. The total sample included was 1000. Workers aged 19-60 years who had worked for at least 2 years were included. A multistage simple random sampling method was used to recruit participants. The oral hygiene practices and behaviour of the workers were assessed using a self-structured 19-item questionnaire. The oral health assessment was done using the WHO Oral Health Assessment Form for Adults, 2013. Oral health-related quality of life (OHRQoL) was assessed using the Oral Health Impact Profile-14 (OHIP-14). Wilson and Cleary's conceptual model was used to analyse the integration of biological and physiological characteristics and the overall quality-of-life outcomes. Statistical analysis was conducted using SPSS version 26. *P*-value<0.05 was considered to be statistically significant.

**Results:** Among all participants, 73.9% were male, and the majority were aged 47-59 (38.6%). Gingival bleeding was significantly associated with the social disability ($p$= 0.006) and handicap ($p$= 0.026) domains of OHRQoL, while mild fluorosis was associated with psychological discomfort ($p$= 0.042) and higher total OHIP scores ($p$= 0.010). The SEM demonstrated poor model fit (SRMR = 0.137, RMSEA = 0.102, CFI = 0.829), and findings were interpreted as exploratory associations.

**Conclusion:** Gingival bleeding and mild fluorosis among beedi factory workers were significantly associated with the social disability and handicap domains of OHRQoL. The biological, functional, and symptomatic factors showed stronger relationships, although the overall fit indices were poor in the SEM analysis.

**Keywords:** *Occupational health; Oral health; Quality of life; OHIP-14; Surveys and questionnaires; Cross-sectional studies*

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## RESUMEN

**Objetivo:** Este estudio tiene como objetivo evaluar el estado de salud bucal, las prácticas de higiene bucal y la calidad de vida relacionada con la salud bucal entre los trabajadores que manufacturan beedi [Ed. cigarrillos de tabaco enrollados a mano] en los distritos del sur de Tamil Nadu, India.

**Materiales y Métodos:** Se realizó un estudio transversal entre trabajadores de fábricas beedi en los distritos sureños de Tirunelveli, Theni y Tenkasi. El total de muestras incluidas fue de 1000. Se incluyeron trabajadores de 19 a 60 años que habían trabajado durante al menos 2 años. Se utilizó un método de muestreo aleatorio simple de múltiples etapas para reclutar a los participantes. Las prácticas y el comportamiento de higiene bucal de los trabajadores se evaluaron mediante un cuestionario autoestructurado de 19 ítems. La evaluación de la salud bucal se realizó utilizando el Formulario de Evaluación de la Salud Bucal para Adultos de la OMS, 2013. La calidad de vida relacionada con la salud bucal (OHRQoL) se evaluó mediante el Perfil de Impacto en la Salud Bucal-14 (OHIP-14). Se utilizó el modelo conceptual de Wilson y Cleary para analizar la integración de las características biológicas y fisiológicas y los resultados generales de calidad de vida. El análisis estadístico se realizó utilizando SPSS versión 26. Se consideró estadísticamente significativo un valor de $p<0,05$.

**Resultados:** Entre todos los participantes, el 73,9% eran hombres y la mayoría tenía entre 47 y 59 años (38,6%). El sangrado gingival se asoció significativamente con los dominios de discapacidad social ($p$ = 0,006) y discapacidad ($p$ = 0,026) de OHRQoL, mientras que la fluorosis leve se asoció con malestar psicológico ($p$ = 0,042) y puntuaciones totales más altas del OHIP ($p$ = 0,010). El SEM demostró un ajuste deficiente del modelo (SRMR = 0,137, RMSEA = 0,102, CFI = 0,829) y los hallazgos se interpretaron como asociaciones exploratorias.

**Conclusión:** El sangrado gingival y la fluorosis leve entre los trabajadores de la fábrica de beedi se asociaron significativamente con los dominios de discapacidad social y discapacidad de OHRQoL. Los factores biológicos, funcionales y sintomáticos mostraron relaciones más fuertes, aunque los índices de ajuste generales fueron deficientes en el análisis SEM.

**Palabras clave:** *Salud laboral; Salud bucal; Calidad de vida; OHIP-14; Encuestas y cuestionarios; Estudios transversales*

## INTRODUCTION

Dental disease, mainly dental caries and periodontal diseases, contributes to social, economic, and health burdens.[1,2] According to the WHO Global Oral Health Status Report (2022), billion individuals worldwide suffer from untreated oral diseases.[3] In India, approximately 28.6% of adults use tobacco in some form, including smoked and smokeless products, contributing significantly to tobacco-related disease burden and mortality.[4,5] There are two forms of tobacco consumption, which include – smoking form and the smokeless form. The most commonly practiced smoking forms of tobacco are beedi, hookah, and cigarettes.[6] The khaini, gutkha, betel quid with tobacco, and zarda are the most commonly used smokeless forms of tobacco.[7]

Small, thin rolled tobacco products are called 'Beedi'. These are also known as 'Bidi'

or 'Biri'. Hand-rolled beedis constitute 90% of all beedi products.[8] According to the Centre for Disease Control and Prevention, India and Southeast Asian countries are the major producers of beedi products.[9] In India, 5.5 million beedi workers are registered. The Beedi industry is household-based, and the work environment is generally more challenging for the workers.[10]

Beedi workers are often exposed to several occupational-related health hazards due to prolonged working hours and an unhealthy working environment.[11] High nicotine content and other harmful chemical products in Beedi act as a risk factor for various systemic diseases. Most of the time, Beedi workers inhale tobacco dust and other toxic substances, which can be hazardous to their health.[12] A study by Subramani et al. reported that 69.1% of all women beedi-rollers experienced health issues, including musculoskeletal disorders (52.7%) and respiratory problems (11%).[13] Due to socioeconomic conditions, most women residents of southern states are employed in beedi factories. In Tamil Nadu, 603,076 registered workers are engaged in beedi rolling.[10] Oral and general health complement each other and play a major role in improving the quality of life. The oral cavity is the source of many diseases.[14] A study by Bhat *et al.*,[15] reported that among the beedi workers in Karnataka, most (2%) had malignant tumours, 6.9% had leukoplakia, and 3% had lichen planus.This study highlights the importance of assessing the oral health status of beedi workers in Tamil Nadu as well.

Most beedi factories in India are in West Bengal, Karnataka, Tamil Nadu, Andhra Pradesh, Madhya Pradesh, Bihar, and other states. In Tamil Nadu, most beedi factories are located in the southern districts. According to recent statistics, 138 registered large beedi companies operate in the Tirunelveli district, particularly in the Alangulam, Palayamkottai, Keelapavoor, and Cheranmahadevi blocks.[16]

There is a lack of evidence on oral health-related diseases among beedi factory workers in Tamil Nadu, as most studies have focused on musculoskeletal, respiratory, and dermatological disorders. This study aims to assess the oral health status, oral hygiene practices and Oral Health Related Quality of Life among Beedi workers in the southern districts of Tamil Nadu.

## MATERIALS AND METHODS

### Study Design and Study Setting

A cross-sectional study was conducted from May 2024 to October 2025 among permanent and contract-based employees working in beedi factories in the southern districts of Tamil Nadu. The southern districts included in the study were Tirunelveli, Theni, and Tenkasi. In Tirunelveli district, beedi factories located in Melapalayam, Munnirpallam, and Mukkudal, and in Tenkasi district, beedi factories located in Alangulam and Pavoorchatram were selected randomly.

### Sample Size Calculation

Based on the prevalence of previous literature17, sample size was determined for the study based on the formula,

$$n = z^2 * p\,(1-p)/\ d^2$$

Thus, after applying the formula $4pq/d^2$, where p (prevalence) = 9.7%; q = 90.3%; d = 20% of p (relative precision), the sample size would be 894. With an anticipated non-response rate of 10%, the adjusted sample size was determined to be 983. As a result, a final sample size of 1000 is obtained after rounding off.

## Ethical Approval

Ethical committee approval was obtained from the Institutional Review Board (IRB) of SRM Dental College, Bharathi Salai, Chennai, TN, India. The IRB number is SRMDC/IRB/2023/MDS/No.702. The study's purpose was properly explained to the participants, and the informed consent form was then distributed.

## Inclusion Criteria

1. Employees of age 19-60 years were included.
2. Employees with more than 2 years of experience.
3. Employees who were willing to participate in the study.

## Exclusion criteria

1. Employees with hearing, speech and intellectual disability.
2. Employees with chronic systemic illnesses
3. Employees who were not present during the date of examination
4. Employees who failed to give consent

## Validation of Self-structured Questionnaire

A structured questionnaire consisting of demographic characteristics, oral hygiene practices, tobacco-related habits and OHIP-14 items was administered.

A self-structured questionnaire comprises 19 items subdivided into four sections: demographic data (7 items), oral health habits (6 items), oral hygiene practices (1 item), and past dental history (5 items). For the English questionnaire, the content validity ratio was 0.91, and Cronbach's alpha was 0.83. This questionnaire was pilot-tested among 50 participants, and inter-examiner reliability was 0.82, and intra-examiner reliability was 0.88.

This questionnaire was translated into Tamil language by experts and back-translated to ensure semantic equivalence. The questionnaire demonstrated content validity ratio of 0.84, and good internal consistency, with a Cronbach's alpha of 0.81. The questionnaire was pilot-tested among 50 participants, and test-retest reliability showed substantial agreement ($\kappa = 0.84$). For the clinical examination, intra-examiner reliability was assessed using Cohen's kappa statistic and demonstrated excellent agreement ($\kappa = 0.88$).

## Participants Recruitment

Multistage random sampling was used to select the districts. The 235 participants were evenly distributed across the districts. The sampling technique used to recruit the participants was stratified random sampling.

The participant recruitment is clearly explained in Figure 1.

## Examination

The principal investigator (BJA) conducted the clinical examination in accordance with ADA Type III examination criteria.18 The WHO Oral Health Assessment Form (2013) was used to assess the oral health status and treatment needs of beedi factory workers.[19]

The self-structured questionnaire was used to assess oral hygiene status, oral health care habits, and the attitude of beedi factory workers towards oral health care services (Appendix 1).

The Oral Health Impact Profile-14 (OHIP-14), comprising 14 items distributed across seven domains (functional limitation, physical pain, psychological discomfort, physical disability, psychological disability, social disability and handicap) was used to assess oral health related quality of life among beedi factory workers.

A 5-point Likert scale was used for scoring, ranging from 0 to 4.20 The total OHIP-14 score ranged from 0 to 56. The validated Tamil version of OHIP-14 was administered whenever required.[21]

**Figure 1**

Participant recruitment flow chart

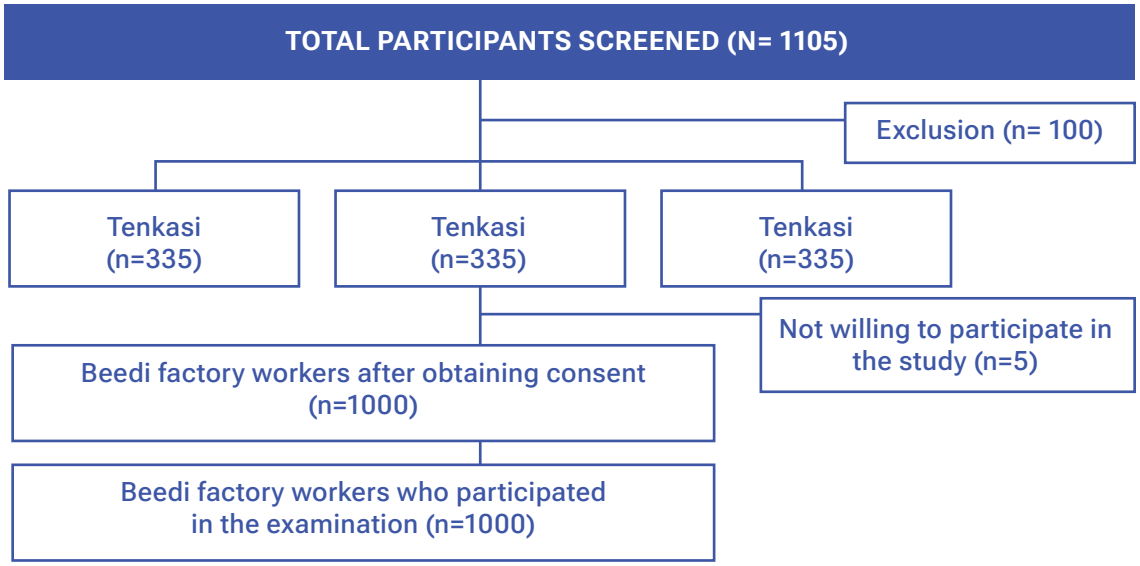
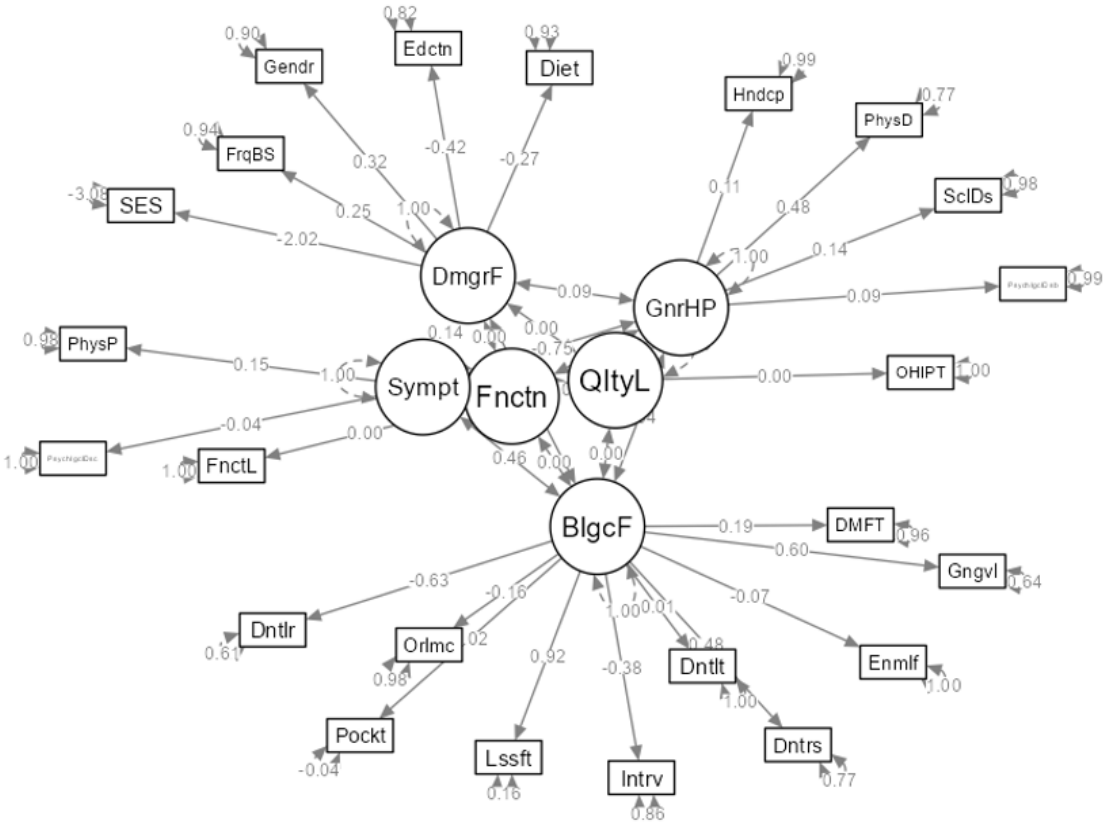



**Figure 2**

Structural Equation Modelling based on Wilson and Cleary Framework.




**BlgcF:** Biological Factor; **DmgrF:** Demographic Factor; **GnrHP:** General Health Perception; **Fnctn:** Functional Health; **Sympt:** Symptom; **QltyL:** Quality of Life; **PhysD:** Physiological Discomfort; **ScIDs:** Social Disability; **Hndcp:** Handicap; **FnctL:** Functional Limitation; **PhysP:** Physical Pain; **PsychlgclDsb:** Psychological Disability; **PsychlgclDsc:** Psychological Discomfort; **OHIPT:** Total OHIP Score; **Gngvl:** Gingival Bleeding; **Pockt:** Pocket; **Lssft:** Loss of Attachment; **Enmlf:** Enamel Fluorosis; **Dntlr:** Dental Erosion; **Dntlt:** Dental Trauma; **Orlmc:** Oral Mucosal Lesion; **Dntrs:** Dentures; **Intrv:** Intervention Urgency; **DMFT:** Decayed, Missing, Filled Teeth; **FrqBS:** Frequency of Beedi Smoking; **Gendr:** Gender; **Edctn:** Education; **SES:** Socioeconomic Status.

### Outcome Variable

The primary outcome was oral health status and treatment needs, and the secondary outcomes were oral health, oral hygiene practices, oral health-related habits, and oral health-related quality of life.

### Theoretical Model

Wilson and Cleary Model (1995) is a conceptual model based on biological and physiological factors of health. It helps analyse the integration of biological and physiological characteristics and the overall quality of life outcomes.[22]

Biological factors included gingival bleeding, periodontal pocket depth, loss of attachment, enamel fluorosis, dental erosion, dental trauma, oral mucosal lesions, denture status, intervention urgency and DMFT score. Symptom status was estimated based on physical pain and psychological discomfort domains of OHIP-14. Functional health included functional limitation. General health perception included physical disability, psychological disability, social disability and handicap domains of OHIP-14. Demographic factors included frequency of beedi smoking, gender, educational level, socioeconomic status using Modified Kuppusamy Scale (2026) and dietary pattern as exogenous variables within the model.

### Statistical Analysis

The data were entered in Microsoft Excel Sheets and analyzed using SPSS version 27.0. The normality of the data was analysed using the Shapiro-Wilk and Kolmogorov-Smirnov Tests. Descriptive statistics were used to summarise variables. Mann-Whitney U Test and Kruskal-Wallis test were used to analyse the association between the study variables. Structural Equation Modelling (SEM) was analysed using Jamovi Software 2.6.4.

This SEM analysis was conducted to investigate the simultaneous effects of observed and latent variables. This was used to assess the direct and indirect effects of variables based on Wilson and Cleary's conceptual model. The overall fit measurement was assessed using the following indices: fit indices (**SRMR:** Standardised root mean square residual; **RMSEA:** root mean square error of approximation), comparative fit index (CFI), Tucker-Lewis Index (TLI), Relative Noncentrality Index (RNI), Bentler-Bonett Normed Fit Index (NFI).[23] *p*-value <0.05 is considered to be statistically significant.

## RESULTS

The descriptive data for the study participants are presented in Table 1. Among all participants, 73.9% were male, and the majority were aged 47-59 (38.6%). A total of 99.9% belonged to the lower middle class, 79.4% had the habit of smoking beedi twice a day, and 54.2% had the habit of consuming alcohol. The majority of the participants were suffering from dental problems (84.9%). Among all the participants, 82.6% did not show any abnormal lesion, followed by 5% showing abscess, 4.6% and 4.7% having ulcerations and acute necrotizing ulcerative gingivitis (ANUG), respectively. In relation to general health, the majority of them suffered from eye diseases (36.4%), and 85.2% of participants have never received any dental services.

The physical disability domain has shown significantly higher mean rank among beedi workers who smoked twice a day. However, all other domains also reported higher mean ranks, but these remained insignificant. (Table 2). The association between oral hygiene behaviour and practices among beedi factory workers showed no significant differences across various domains of OHR-QoL, (Table 3).

The presence of gingival bleeding was significantly higher mean rank across social disability and handicap domain.

Mild fluorosis showed substantially higher mean ranks across the psychological discomfort domain and total OHIP scores. All other clinical parameters have shown no significant association across various domains of OHRQoL. (Table 4.)

The SEM based on the Wilson and Cleary framework demonstrated inadequate overall model fit. The model chi-square test was statistically significant (χ2: 2446, df: 215, χ2/df: 11.4, $p<0.001$) indicating discrepancies between the observed and model-implied covariance matrices (Table S1).

The absolute fit indices indicate a poor fit across the variables, with 95% CI (SRMR=0.137; RMSEA=0.102, $p<0.001$), as the values exceed the threshold (Table S2).

**Table 1**

Descriptive data of study participants

| | | Frequency (n) | Percentage (%) |
|---|---|---|---|
| Gende | Male | 739 | 73.9 |
| | Female | 261 | 26.1 |
| Age | 21 – 29 Years | 12 | 1.2 |
| | 30 – 38 Years | 228 | 22.8 |
| | 39 – 46 Years | 374 | 37.4 |
| | 47 – 59 Years | 386 | 38.6 |
| Education | Middle school certificate | 199 | 19.9 |
| | Primary school certificate | 403 | 40.3 |
| | Illiterate | 398 | 39.8 |
| Income | ≥7988 | 24 | 2.4 |
| | 7989-23869 | 246 | 24.6 |
| | 23870-39829 | 639 | 63.9 |
| | 39830-59794 | 91 | 9.1 |
| | 2734-4556 | 17 | 1.7 |
| Socioeconomic Status | Lower Middle Class | 999 | 99.9 |
| | Lower | 1 | 0.1 |
| Diet | Vegetarian | 54 | 5.4 |
| | Mixed Diet | 946 | 94.6 |
| Sweet Consumption Pattern | Once | 990 | 99 |
| | Twice | 10 | 1 |
| Frequency of Smoking | Once | 206 | 20.6 |
| | Twice | 794 | 79.4 |
| Alcohol Consumption | Yes | 542 | 54.2 |
| | No | 458 | 45.8 |
| Presence of a Dental Problem | Yes | 849 | 84.9 |
| | No | 151 | 15.1 |
| Any Other Disease | Rashes | 258 | 25.8 |
| | Eye Disease | 364 | 36.4 |
| | Backpain | 280 | 28 |
| | Any other disease | 98 | 9.8 |
| Previous Dental Visit | Yes | 148 | 14.8 |
| | No | 852 | 85.2 |
| Oral Mucosal Lesion | No abnormal condition | 836 | 83.6 |
| | Malignant Tumour | 10 | 1 |
| | Leukoplakia | 21 | 2.1 |
| | Ulceration | 46 | 4.6 |
| | ANUG | 47 | 4.7 |
| | Abscess | 50 | 5 |

All values are expressed as frequency with percentages. **ANUG:** acute necrotizing ulcerative gingivitis.

## Table 2

Association of Frequency of Beedi Smoking and OHRQoL

| | Functional Limitation | Physical Pain | Psychological Discomfort | Physical Disability | Psychological Disability | Social Disability | Handicap | TOTAL OHIP |
|---|---|---|---|---|---|---|---|---|
| Once | 493.59 | 490.47 | 477.80 | 465.54 | 510.27 | 501.83 | 495.99 | 479.10 |
| Twice | 502.29 | 503.10 | 506.39 | 509.57 | 497.97 | 500.27 | 501.67 | 506.05 |
| *p*-value | 0.690 | 0.564 | 0.190 | 0.044* | 0.574 | 0.960 | 0.796 | 0.231 |

*p*-value <0.05 is considered statistically significant for the Kruskal-Wallis test. All values are expressed as Mean Rank.

## Table 3

Association of Oral Hygiene Practices and OHRQoL

| | Functional Limitation | Physical Pain | Psychological Discomfort | Physical Disability | Psychological Disability | Social Disability | Handicap | TOTAL OHIP |
|---|---|---|---|---|---|---|---|---|
| **Type of cleaning aid used** | | | | | | | | |
| Toothbrush & Toothpaste | 497.17 | 505.17 | 497.66 | 502.68 | 495.34 | 506.02 | 499.38 | 499.74 |
| Toothbrush & Powder | 523.01 | 468.96 | 519.70 | 485.81 | 535.34 | 463.20 | 508.07 | 505.61 |
| *p*-value | 0.326 | 0.171 | 0.403 | 0.523 | 0.130 | 0.104 | 0.743 | 0.829 |
| **Method of brushing** | | | | | | | | |
| Horizontal | 499.50 | 482.32 | 476.70 | 499.42 | 524.95 | 520.62 | 524.90 | 510.28 |
| Vertical | 476.70 | 511.15 | 503.72 | 504.91 | 496.31 | 474.61 | 485.37 | 477.92 |
| Both | 520.37 | 525.86 | 515.99 | 514.97 | 489.02 | 493.36 | 482.75 | 518.45 |
| Circular | 520.62 | 474.11 | 506.63 | 476.51 | 490.44 | 529.83 | 517.77 | 506.89 |
| *p*-value | 0.201 | 0.168 | 0.457 | 0.555 | 0.465 | 0.093 | 0.217 | 0.339 |
| **Frequency of tooth brushing** | | | | | | | | |
| Once | 510.26 | 503.45 | 504.93 | 500.86 | 500.88 | 505.70 | 497.87 | 510.26 |
| Twice | 455.27 | 464.44 | 474.19 | 510.46 | 481.88 | 485.57 | 521.17 | 455.27 |
| Thrice | 480.14 | 529.96 | 500.40 | 481.26 | 526.50 | 475.07 | 492.48 | 480.14 |
| *p*-value | 0.068 | 0.203 | 0.504 | 0.756 | 0.522 | 0.512 | 0.653 | 0.101 |
| **Duration of brushing** | | | | | | | | |
| 2-4min | 485.55 | 483.08 | 511.86 | 497.19 | 507.95 | 517.58 | 499.63 | 498.03 |
| >5min | 514.85 | 504.50 | 499.67 | 501.08 | 491.00 | 486.96 | 505.27 | 503.10 |
| not noticed | 502.58 | 519.84 | 485.51 | 504.42 | 502.58 | 494.31 | 495.40 | 500.53 |
| *p*-value | 0.360 | 0.246 | 0.497 | 0.948 | 0.708 | 0.304 | 0.908 | 0.972 |
| **Frequency of changing toothbrush** | | | | | | | | |
| 1-2 months | 281.25 | 586.50 | 353.25 | 859.00 | 229.00 | 472.50 | 424.25 | 406.25 |
| 3 mon | 489.55 | 501.14 | 488.28 | 484.13 | 521.75 | 500.42 | 505.43 | 499.10 |
| 4-6 mon | 504.31 | 492.30 | 493.19 | 509.07 | 503.71 | 483.35 | 499.44 | 493.92 |
| 7-12 mon | 509.29 | 512.29 | 528.21 | 503.76 | 471.67 | 528.48 | 496.83 | 513.53 |
| *p*-value | 0.559 | 0.798 | 0.259 | 0.188 | 0.089 | 0.237 | 0.961 | 0.806 |
| **Other cleaning aids are used** | | | | | | | | |
| Yes | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NO | 500.50 | 500.50 | 500.50 | 500.50 | 500.50 | 500.50 | 500.50 | 500.50 |
| *p*-value | - | - | - | - | - | - | - | |

*p*-values < 0.05 are considered statistically significant using the Mann-Whitney U test and the Kruskal-Wallis test. All values are expressed as Mean Rank.

## Table 4

Association of Oral Health Status and OHRQoL

| | Functional Limitation | Physical Pain | Psychological Discomfort | Physical Disability | Psychological Disability | Social Disability | Handicap | TOTAL OHIP |
|---|---|---|---|---|---|---|---|---|
| **Gingival Bleeding** | | | | | | | | |
| Presence | 504.97 | 492.11 | 508.16 | 502.06 | 501.29 | 485.01 | 513.21 | 501.37 |
| Absence | 489.61 | 520.93 | 481.83 | 496.69 | 498.57 | 538.23 | 469.54 | 498.37 |
| *p*-value | 0.428 | 0.140 | 0.176 | 0.783 | 0.889 | 0.006* | 0.026* | 0.881 |
| **Pocket** | | | | | | | | |
| 4-5mm | 499.79 | 495.21 | 499.46 | 495.50 | 503.85 | 498.44 | 502.95 | 497.94 |
| More than 6 mm | 504.77 | 532.22 | 506.71 | 530.49 | 480.41 | 512.85 | 485.82 | 515.86 |
| *p*-value | 0.843 | 0.144 | 0.774 | 0.167 | 0.354 | 0.568 | 0.500 | 0.490 |
| **Loss Of Attachment** | | | | | | | | |
| 4-5mm | 498.15 | 494.27 | 500.40 | 496.25 | 501.13 | 496.16 | 504.62 | 495.18 |
| 6-8mm | 516.52 | 542.95 | 501.17 | 529.45 | 496.20 | 530.04 | 472.43 | 536.75 |
| *p*-value | 0.486 | 0.066 | 0.977 | 0.210 | 0.852 | 0.200 | 0.226 | 0.126 |
| **Enamel Fluorosis** | | | | | | | | |
| Questionable | 491.64 | 491.41 | 444.17 | 487.92 | 477.64 | 476.16 | 453.74 | 426.93 |
| Very Mild | 501.40 | 501.42 | 506.21 | 501.77 | 502.82 | 502.97 | 505.24 | 507.95 |
| *p*-value | 0.749 | 0.744 | 0.042* | 0.651 | 0.411 | 0.380 | 0.094 | 0.010* |
| **Dental Erosion** | | | | | | | | |
| Enamel Lesion | 505.09 | 501.13 | 499.07 | 498.56 | 501.48 | 501.77 | 503.43 | 502.21 |
| Dentinal Lesion | 472.30 | 496.66 | 509.27 | 512.39 | 494.49 | 492.68 | 482.53 | 490.01 |
| *p*-value | 0.196 | 0.861 | 0.689 | 0.588 | 0.784 | 0.721 | 0.414 | 0.642 |
| **Dental Trauma** | | | | | | | | |
| Treated Injury | 478.31 | 492.88 | 491.93 | 517.50 | 505.17 | 507.95 | 503.31 | 502.82 |
| Enamel Fracture Only | 506.15 | 502.44 | 502.68 | 496.17 | 499.31 | 498.60 | 499.79 | 499.91 |
| *p*-value | 0.204 | 0.664 | 0.624 | 0.333 | 0.790 | 0.670 | 0.873 | 0.898 |
| **Oral Mucosal Lesions** | | | | | | | | |
| No abnormal Condition | 497.97 | 495.85 | 503.89 | 495.77 | 495.30 | 501.43 | 493.15 | 492.71 |
| Malignant Tumour | 635.90 | 427.50 | 530.15 | 482.50 | 529.65 | 307.55 | 424.15 | 452.50 |
| Leukoplakia | 561.31 | 477.80 | 480.52 | 542.48 | 467.14 | 513.38 | 480.74 | 503.40 |
| Ulceration | 461.40 | 481.55 | 473.05 | 570.13 | 548.02 | 548.46 | 559.80 | 566.14 |
| ANUG | 535.50 | 514.78 | 501.32 | 471.28 | 463.60 | 448.39 | 540.57 | 483.34 |
| Abscess | 492.68 | 605.53 | 471.46 | 527.96 | 585.62 | 523.25 | 553.25 | 593.39 |
| *p*-value | 0.405 | 0.137 | 0.936 | 0.471 | 0.186 | 0.147 | 0.118 | 0.291 |
| **Denture** | | | | | | | | |
| Partial Denture | 456.63 | 521.93 | 551.60 | 519.48 | 489.10 | 497.33 | 525.98 | 522.56 |
| Complete Denture | 503.30 | 499.13 | 497.24 | 499.29 | 501.23 | 500.70 | 498.87 | 499.09 |
| *p*-value | 0.208 | 0.541 | 0.144 | 0.588 | 0.745 | 0.928 | 0.469 | 0.540 |
| **Intervention Urgency** | | | | | | | | |
| Preventive or Routine Treatment | 362.50 | 634.75 | 723.75 | 636.75 | 503.50 | 619.25 | 452.25 | 653.00 |
| Prompt Treatment | 506.19 | 497.16 | 499.20 | 495.29 | 511.48 | 497.28 | 493.31 | 500.19 |
| Intermediate Treatment | 482.20 | 510.27 | 501.87 | 519.72 | 458.77 | 511.37 | 528.43 | 500.06 |
| Referred or Comprehensive Treatment | 217.00 | 772.00 | 781.50 | 223.50 | 778.00 | 472.50 | 285.00 | 530.00 |
| *p*-value | 0.428 | 0.622 | 0.510 | 0.436 | 0.075 | 0.850 | 0.352 | 0.902 |

*p*-values < 0.05 are considered statistically significant for the Mann-Whitney U test and the Kruskal-Wallis test. All values are expressed as Mean Rank. **ANUG:** acute necrotizing ulcerative gingivitis

Incremental fit indices demonstrated moderate fit (CFI=0.829,TLI=0.799,RNI=0.829,NFI=0.816, IFI = 0.830 and PNFI = 0.694), (Table S3). Within the measurement model, the biological factor construct was primarily represented by periodontal pocket depth (β = 1.0199), loss of attachment (β = 0.9154), and gingival bleeding (β = 0.5962), while enamel fluorosis, dental erosion, oral mucosal lesions, and intervention urgency demonstrated weaker or negative loadings.

The demographic factor construct included frequency of beedi smoking (β = 0.2470), gender (β = 0.3236), education (β = −0.4191), socioeconomic status (β = −2.0205), and dietary pattern (β = −0.2735). General health perception was represented by physical disability (β = 0.4751), psychological disability (β = 0.0944), social disability (β = 0.1387), and handicap (β = 0.1066). These findings should be interpreted cautiously because the overall model fit was suboptimal.

The presence of gingival bleeding has been reported to have a significantly higher mean rank across handicap domain while absence of gingival bleeding showed higher mean rank among social desirability domain. Mild fluorosis showed substantially higher mean ranks across the psychological discomfort domain and total OHIP scores. All other clinical parameters have shown no significant association across various domains of OHRQoL, (Table 4.).

## DISCUSSION

Tobacco is a significant risk factor for periodontal diseases and oral cancer. Beedi factory workers are often exposed to tobacco dust during beedi rolling, posing an occupational hazard.[17] Our study was the first of its kind to establish the association between oral health status, oral hygiene practices, and oral health-related quality of life among Beedi factory workers across the southern districts of Tamil Nadu.

Beedi factory workers demonstrated a high prevalence of beedi smoking which was associated with poorer oral health related quality of life. The majority of participants belonged to the lower middle socioeconomic class, which may be associated with lower utilization of dental services and a higher burden of oral lesions. In our study the majority of the factory workers who smoked were males between the ages of 47-59 years, indicating older males are at a higher risk of developing tobacco-related diseases. Similar findings were reported by Bhat et al., who found that 54% of patients in the middle-aged group were male,[15] while Singh et al. reported that 76% were females.[17] Previous studies have focused exclusively on female workers.[24-26] Most participants (84.9%) had dental problems. Beedi contains a nitrosamine component, which leads to epithelial dysplasia, keratinocyte DNA damage, and malignant transformation. Constant exposure to chemicals creates a favourable environment for the development of mucosal lesions.

The majority of participants did not show any abnormal lesions, followed by abscess (5%), ulceration (4.7%), and ANUG (4.6%), similar to what has been previously reported, where beedi factory workers in Karnataka suffered from malignant tumours (2.1%) and leukoplakia (3.1%).[15] Our study also demonstrated a similar pattern of malignant tumour (1%) and leukoplakia (2.1%). Most workers reported smoking beedis twice daily, which has been reported in previous literature to be associated with adverse oral health outcomes.

Our study has reported no significant association between oral hygiene behaviour and practices among beedi factory workers across various domains of OHRQoL. Most participants used a toothbrush and toothpaste,

and neither brushing frequency nor method had a measurable impact on quality-of-life scores. No significant association was observed between oral hygiene practices and OHRQoL domains among beedi factory workers in the present study.

The present study reported the presence of gingival bleeding significantly associated with the social disability and handicap domains of OHRQoL, indicating that workers with gingival bleeding may experience symptoms such as halitosis, pain or compromised appearance which may contribute to poorer perceived OHRQoL.

Mild fluorosis demonstrated a significant association with the psychological discomfort domain and total OHIP scores possibly reflecting aesthetic concerns. Fluorosis does not have any direct link to beedi use. While the contradictory findings reported by Divvi et al., among tobacco factory workers, showed no significant differences in oral health status across various domains of OHRQoL.[27]

Although SEM analysis shows several standardized pathways were statistically significant and aligned with theoretical basis, the overall model demonstrated inadequate fit. The poor model fit suggests that the proposed model may not fully capture the complexity of oral health outcomes in this occupational group and additional unmeasured variables such as duration of occupational exposure, workplace environment, psychosocial stress, healthcare access, and tobacco dependence may contribute substantially to OHRQoL. Therefore, SEM findings were only exploratory and hypothesis generating rather than confirmatory evidence of structural relationships.

The major strength of the study is the inclusion of large samples across various southern districts, thereby enhancing the generalisability and external validity of its findings. The clinical examination, along with the assessment of OHRQoL measures, broadens the scope of oral health outcomes. The validated SEM analysis to find the association between variables strengthens the reliability of the study. The biological plausibility of the study on the role of the nitrosamine component in beedi and its intraoral effects strengthens the study's internal validity. In addition to the study's strengths, there are a few limitations. Cross-sectional research cannot establish a causal relationship between variables.

Secondly, self-reported data are subject to recall bias. A longitudinal study should examine occupational exposure, and a behavioural intervention should be specifically planned for people with low literacy levels. Health promotion in the workplace setting would help minimise barriers to dental care. Regular screening camps and tobacco cessation initiatives exclusively for the tobacco factory workers will help in reducing the overall burden of the disease.

## CONCLUSIONS

The beedi factory workers in the Southern districts of Tamil Nadu have demonstrated significant associations between gingival bleeding, social disability and handicap domains of OHRQoL, while mild fluorosis was associated with psychological discomfort and higher total OHIP scores. Oral hygiene practices were not significantly associated with OHRQoL, while occupational and behavioural factors demonstrated associations with oral health outcomes.

The biological, functional, and symptomatic factors showed stronger relationships, although the overall fit indices were poor in the SEM analysis. Improvements in preventive services, access to dental care, and health promotion strategies are essential for oral health and the overall well-being of vulnerable populations.

## REFERENCES

1. Peres MA, Macpherson LMD, Weyant RJ, Daly B, Venturelli R, Mathur MR, Listl S, Celeste RK, Guarnizo-Herreño CC, Kearns C, Benzian H, Allison P, Watt RG. Oral diseases: a global public health challenge. Lancet. 2019 Jul 20;394(10194):249-260. https://doi.org/110.1016/S0140-6736(19)31146-8. Erratum in: Lancet. 2019 Sep 21;394(10203):1010. https://doi.org/110.1016/S0140-6736(19)32079-3. PMID: 31327369.
2. Mathur MR, Singh A, Watt R. Addressing inequalities in oral health in India: need for skill mix in the dental workforce. J Family Med Prim Care. 2015 Apr-Jun;4(2):200-2. https://doi.org/10.4103/2249-4863.154632. PMID: 25949967; PMCID: PMC4408701.
3. Organization WH. Global oral health status report: towards universal health coverage for oral health by 2030. World Health Organization; 2022.
4. Bhandari Y, Kishore J, Yadav A. Tobacco use and dependence among adults residing in an urbanized village, Delhi, India. J Family Med Prim Care. 2024 Feb;13(2):477-485. https://doi.org/10.4103/jfmpc.jfmpc_264_23. Epub 2024 Mar 6. PMID: 38605801; PMCID: PMC11006084.
5. Kalan ME, Mejia R, Egbe CO, Chopra M, Bteddini D, Jebai R, et al. E-cigarette use in low-income and middle-income countries: opportunity or challenge for global tobacco control. Lancet Glob Health. 2023;11(12):e1855–6.
6. Anand K, Kanishka MS, Marwah S. Prevalence and determinants of hookah use among college-going women of Delhi. Natl Med J India. 2019;32(5):277–81.
7. Gupta PC, Ray CS. Smokeless tobacco and health in India and South Asia. Respirology. 2003 Dec;8(4):419–31.
8. Mallick J, Satpathy S. Estimation of Women Beedi Workers in India and Their Socio-economic Condition. Indian J Labour Econ. 2021 June;64(2):499–521.
9. Control C for D, Prevention (CDC. Bidi use among urban youth–Massachusetts, March-April 1999. MMWR Morb Mortal Wkly Rep. 1999;48(36):796–9.
10. Alternative livelihood for women and children bidi workers. 2025.
11. Singh JK, Rana SVS, Mishra N. Occupational Health Problems amongst Women Beedi Rollers in Jhansi, Bundelkhand Region, Uttar Pradesh. J Ecophysiol Occup Health. 2014 J;14(1–2):17.
12. Joshi KP, Robins M, Parashramlu V, Mallikarjunaih KM. An epidemiological study of occupational health hazards among bidi workers of Amarchinta, Andhra Pradesh. Cough Bronchitis. 2013;128:27–24.
13. Subramani DP, Chidambaram S, Elangovan V, Ramakrishnan S, Nagarajan G, Veeraiah S. Health, economic, occupational effects and readiness for alternative livelihood among beedi rolling women in Tamil Nadu: A cross-sectional study. Cancer Res Stat Treat. 2025 July;8(3):190–6.
14. Schour I, Sarnat B. Oral manifestations of occupational origin. JAMA Network. 1942; 120(15): 1197-1207.
15. Bhat PK, Kumar A, Aruna CN, Badiyani BK, Jayachandra MY. Assessment of oral mucosal conditions among beedi workers residing in beedi workers colonies in Karnataka, India. J Oral Maxillofac Pathol. 2018 Sep-Dec;22(3):298-302. https://doi.org/1010.4103/jomfp.JOMFP_140_18. PMID: 30651670; PMCID: PMC6306609.
16. Khader JA, Hameed AI, Siddik MM. Socio-Economic Conditions Of Beedi Workers With Reference To Melapalayam Town (Tirunelveli District) In Tamil Nadu. J Pharm Negat Results. 2022; 13(8): 1055-1059.
17. Singh A, Sinha RK, Richa S, Kumar R, Kishor A, Kumar A. Assessment of Periodontal Status and Treatment Needs among Beedi Factory Workers. J Pharm Bioallied Sci. 2021 Jun;13(-Suppl 1):S237-S240. https://doi.org/10.4103/jpbs.JPBS_699_20. Epub 2021 Jun 5. PMID: 34447084; PMCID: PMC8375880.
18. Dunning JM. Principles of dental public health. Harvard University Press; 1986.

19. Organization WH. Oral health surveys: basic methods. World Health Organization; 2013.
20. Slade GD. Derivation and validation of a short-form oral health impact profile. Community Dent Oral Epidemiol. 1997 Aug;25(4):284-90. https://doi.org/10.1111/j.1600-0528.1997.tb00941.x. PMID: 9332805.
21. Anu V, Arshitha R, Christy AS, Ukkipandian A, Vaithiyanathan A. Validation of A Tamil Version of Oral Health Impact Profile-14 [Ohip-14 (Tamil)]. Ann Romanian Soc Cell Biol. 2021;19990–20000.
22. Wilson IB, Cleary PD. Linking clinical variables with health-related quality of life. A conceptual model of patient outcomes. JAMA. 1995 Jan 4;273(1):59-65. PMID: 7996652.
23. Hu L, Bentler PM. Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. Struct Equ Model Multidiscip J. 1999 Jan;6(1):1–55.
24. Vanishree N, Sequeira PS, Rao A, Gupta N, Chandrashekar BS, Mohan ANJ. Oral health status and treatment needs of female beedi factory workers in Mangalore city, India. Al Ameen J Med Sci. 2014; 7(1): 26-33.
25. Shetty PJ, Hegde V, George RM. A cross-sectional study to assess tobacco use, oral mucosal conditions and periodontal status among 35–44-year-old women beedi rollers, attending outreach programmes in Mangalore city. Guident. 2020;13(5):36.
26. Aparna T, Aruna MS. Occupational Health Problems Among Women Beedi Workers in an Urban-Field Practice Area Cross-Sectional Study. RGUHS Natl J Public Health. 2025;10(1).
27. Divvi A, Chaly PE, Sivasamy S, Mohammed J, Nijesh EJ, Kengadaran S, et al. Oral health status and related quality of life among tobacco factory and cotton ginning mill workers in Guntur city, Andhra Pradesh, India. Popul Med. 2019; 1(November):2.

## CONFLICT OF INTERESTS

The authors declare no conflict of interest.

## ETHICS APPROVAL

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## AUTHORS' CONTRIBUTIONS

**A. Banu Jothi:** Conceptualization, methodology, investigation, formal analysis, writing original draft.
**M Rajmohan:** Validation, writing-review and editing.
**Lubna Fathima:** Conceptualization, supervision, review and editing of the draft.
**Sindhu Ravichandran:** Data curation, Writing-review and editing.
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## SUPPLEMENTARY TABLES

The overall fit of the measurements based on the model test for the user model was significant (χ2: 2446, df: 215, χ2/*df*: 11.4) (Table S1). The fit indices indicate a poor fit across the variables, with 95% CI (SRMR=0.13; RMSEA=0.10), as the values exceed the threshold (Table S2).

The other fit indices have shown moderate fit (CFI=0.82, TLI=0.79, RNI=0.82, NFI=0.81). (Table S3). The Wilson and Cleary Framework, based on SEM Analysis, shows a strong association with biological factors (Pocket depth (β=1.02), Loss of Attachment (β=0.92), and Gingival Bleeding (β=0.60)). There was a negative association with demographic factors (Education (β=-0.42), Socioeconomic Status (β=-2.02), and Diet (β=-0.27)). General health perception demonstrated statistically significant loadings within the exploratory SEM model ((Psychological Disability (β = 0.09), Social Disability (β = 0.13), Handicap (β = 0.10)). The symptom factor and quality-of-life factor exhibited a strong association. (Figure 2 and Table S4).

### Table S1

Model test

| Label | $X^2$ | df | p-value |
|---|---|---|---|
| User Model | 2446 | 215 | <.001 |
| Baseline Model | 13313 | 253 | <.001 |
| Scaled User | | 215 | |
| Scaled Baseline | 9162 | 253 | <.001 |

### Table S2

Fit Indices

| | | | 95% Confidence Intervals | | |
|---|---|---|---|---|---|
| Type | SRMR | RMSEA | Lower | Upper | RMSEA p |
| Classical | 0.137 | 0.102 | 0.098 | 0.106 | <.001 |
| Robust | 0.119 | | | | |
| Scaled | 0.119 | | | | |

### Table S3

User Model

| | Model |
|---|---|
| Comparative Fit Index (CFI) | 0.829 |
| Tucker-Lewis Index (TLI) | 0.799 |
| Bentler-Bonett Non-normed Fit Index (NNFI) | 0.799 |
| Relative Noncentrality Index (RNI) | 0.829 |
| Bentler-Bonett Normed Fit Index (NFI) | 0.816 |
| Bollen's Relative Fit Index (RFI) | 0.784 |
| Bollen's Incremental Fit Index (IFI) | 0.830 |
| Parsimony Normed Fit Index (PNFI) | 0.694 |

## Table S4

Measurement Model

| Label | Latent | Observed | Estimate and β |
|---|---|---|---|
| p1 | General Health Perception | Physical Disability | 0.475 |
| p2 | | Psychological Disability | 0.094 |
| p3 | | Social Disability | 0.139 |
| p4 | | Handicap | 0.107 |
| p5 | Function | Functional Limitation | 0.000 |
| p6 | Symptom | Physical Pain | 0.153 |
| p7 | | Psychological Discomfort | -0.042 |
| p8 | Quality of Life | OHIP Total Score | 0.000 |
| p9 | Biological Factors | Gingival Bleeding | 0.596 |
| p10 | | Pocket | 1.020 |
| p11 | | Loss Of Attachment | 0.915 |
| p12 | | Enamel Fluorosis | -0.070 |
| p13 | | Dental Erosion | -0.627 |
| p14 | | Dental Trauma | 0.013 |
| p15 | | Oral Mucosal Lesions | -0.157 |
| p16 | | Dentures | 0.483 |
| p17 | | Intervention Urgency | -0.378 |
| p18 | | Decayed, Missing, and Filled Teeth | 0.190 |
| p19 | Demographic Factors | Frequency of Beedi Smoking | 0.247 |
| p20 | | Gender | 0.324 |
| p21 | | Education | -0.419 |
| p22 | | Socioeconomic Status | -2.020 |
| p23 | | Diet | -0.273 |