What explains socioeconomic inequalities in dental flossing? Cross-sectional results from the RaNCD cohort study

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Keywords

Dental flossing • Health inequalities • Concentration index • Decomposition analysis

Summary

Introduction. *The magnitude and underlying determinants of socio-economic inequality in dental flossing are poorly understood in Iran. This study aimed to measure and decompose socioeconomic inequalities in dental flossing in Ravansar, Iran.*

Methods. *Data of 10,002 individuals aged 35-65 years who participated in the Ravansar Non- communicable Diseases (RaNCD) cohort study in Kermanshah province, western Iran, were analyzed. Based on an asset-based method, socioeconomic status (SES) was measured using principal component analysis (PCA). The concentration index and curve were employed to measure socioeconomic inequality in dental flossing. Decomposition analysis was used to estimate the contribution of each determinant to the overall inequality.*

Results. *Of 10,002 participants, 11.74% were found to practice dental floss. The normalized CI for dental flossing was 0.327 in the entire population, 0.323 in females and 0.329 in males, indicating that the use of dental floss is more concentrated among high-SES individuals. The decomposition analysis indicated that SES (50.58%) and level of education (44.90%) respectively contributed the most to this inequality. Place of residence (10.55%) and age group (2.7%) were the next main contributors, respectively.*

Conclusions. *We found a low prevalence of dental flossing among participants in RaNCD study. We also observed a relatively high degree of pro-rich inequality in dental flossing. The observed inequality was mainly explained by socioeconomic status, level of education and place of residence. Policy interventions should consider these factors to reduce inequalities in dental flossing.*

Introduction

Dental problems are major public health concerns [1] and impact negatively on the quality of life [2]. Almost all adult individuals in the world suffer from dental caries [3]. Oral and dental problems impose a substantial economic burden on individuals, households, and society as a whole [1]. Direct and indirect costs of oral diseases account for around 7% of global health expenditures, implying a high relevance for oral diseases prevention [4]. The disadvantaged bear the greatest fraction of the global burden of oral diseases [5].

It has been indicated that self-performed preventive strategies (e.g., tooth brushing and dental flossing) are cost-effective ways to improve oral health conditions [6]. Regular dental flossing can remove a large portion (i.e., up to 80%) of interdental plaque [7], which impacts both incidences of dental caries and the prevention of periodontal disease [8]. A systematic review indicated that dental flossing, in addition to tooth brushing, has a more effect on the reduction of gingivitis compared to toothbrushing alone [9]. For this reason, the American Dental Associations recommend flossing at least once a day to help remove plaque [10]. Although adherence to such oral hygiene behavior is necessary, a great proportion of individuals floss their teeth less than recommended [11].

Evidence shows that the practice of dental floss in many developing countries like Iran is still low [12]. Moreover, previous reports have indicated that the prevalence of oral and dental problems are unequally distributed across socioeconomic groups, so that individuals with lower socioeconomic status (SES) have a higher burden of dental diseases compared to those of higher SES [13-15]. Socioeconomic inequalities in oral health status have been observed in both developing and developed countries [16]. There is a limited number of studies that have assessed inequalities in oral health outcomes. Most of the existing studies in Iran have only assessed the relationship between SES and oral health status and behaviors, without measuring the extent of socioeconomic-related inequalities in this field [17]. Moreover, to the best of our knowledge, no study has been yet measured socioeconomic inequalities in the practice of dental floss as specific oral hygiene behavior. To fill this gap, this study aimed to quantify: 1) the degree of socioeconomic inequalities in dental flossing; (2) the contribution of each determinant to the measured inequality. The results

may be helpful to plan public health policies in oral health fields.

Study population and methodology study setting and sample

This was a cross-sectional analysis of the Ravansar Non-communicable Disease (RaNCD) cohort study. The RaNCD is one of the Prospective Epidemiological Research Studies in IrAN (PERSIAN) [18]. The RaNCD covers adults, aged 35 to 65 years, living in rural and urban areas of Ravansar, which is geographically located in Kermanshah province, west of Iran. The initial sample consisted of 10,086 individuals, 84 of whom were excluded due to incomplete data.

VARIABLES

The SES of individuals was measured using an asset-based approach. The data on housing conditions (e.g. type of homeownership, the number of rooms,) infrastructure facilities (sanitation facility, source of drinking water) and ownership of a range of durable assets (e.g., car, dishwasher, television, etc.) was used to measure SES of individuals. The SES was constructed using principal component analysis (PCA) technique. The PCA generates the weight for each selected asset and then estimates a continuous index based on the sum of all weights of variables included in the PCA for each individual. The index was used to categorize individuals into five SES quintile (from poorest to richest) [19-22]. Other independent variables included age, sex, level of education, marital status and place of residence (i.e. urban and rural). Dental flossing was our dependent variable which was defined dichotomously.

MEASURING INEQUALITY

Inequality in the practice of dental floss was measured using the concentration index (CI). CI is defined based on a concentration curve (CC). These measures are widely used as standard tools for assessing inequalities in health [23, 24]. The concentration curve is a graphical representation of the degree of inequality that plots the cumulative percentage of the health outcome (vertical axis) against the cumulative percentage of the population, ranked based on their rank in SES group (horizontal axis). The 45° line represents perfect equality, meaning that everyone, regardless of their SES, has precisely the same value of the health outcome variable. If the health outcome variable is concentrated among low-SES individuals, the concentration curve lies above the equality line and vice versa. The further the curve is below (above) the 45° line, the more concentrated the health outcome variable is among the high-SES individuals (low-SES individuals). The CI, which ranges between -1 and +1, equals two times the space between the concentration curve and the equality line and shows whether the outcome variable is concentrated among low- or high-SES individuals. Negative and positive values of this index respectively show that the health

outcome variable is more concentrated in low- and high-SES individuals, while zero values suggest that the health outcome variable is equally distributed among the SES groups. The following formula was used to calculate the CI [23]:

$$(1) \qquad CI = \frac{2 * cov(y_i r_i)}{\mu}$$

Where y_i is the health outcome variable (i.e. dental flossing); μ denotes its mean; and r_i represent the fractional rank of the ith individual in the socioeconomic distribution. As the dental flossing in this study was binary, we used Wagstaff's normalization method to measure inequality in the use of dental floss as follow:

$$CI_{normalized} = \frac{CI}{1-\mu}$$

We decomposed the CI to determine the underlying causes of socioeconomic inequalities in dental flossing. According to Wagstaff for any linear additive regression model linking our health outcome variable (i.e. dental flossing), y to a set of k determinants, x_k [25]:

$$(2) \qquad y = \alpha + \sum_k \beta_k x_k + \varepsilon$$

The CI for dental flossing, y, can be decomposed as follows:

$$(3) \qquad CI = \sum_k \left(\frac{\beta_k \bar{x}_k}{\mu}\right) CI_k + GC_\varepsilon/\mu$$

Where $\bar{x}_k$ denotes the mean of determinant k; the CI_k is the CI for x_k; $\frac{\beta_k \bar{x}_k}{\mu}$ is the elasticity of dental flossing with respect to determinant k.

The elasticity of each determinant demonstrates the responsiveness of dental flossing to changes in the determinant. A positive elasticity means that individuals with this characteristic are more likely to practice dental floss. The GC_ε indicates the generalized CI for the error term. The first part in equation 3, $\sum_k \left(\frac{\beta_k \bar{x}_k}{\mu}\right) CI_k$, is the explained component and indicates the contribution of explanatory variables to the overall socioeconomic inequality in dental flossing. The second part of the equation, GC_ε/μ, is an unexplained (residual) component and shows the portion of the CI for dental flossing that cannot be explained by the systematic variations in the determinants across SES groups.

Wagstaff-type decomposition analysis was performed using the following formula [25]:

$$(4) \qquad CI_{normalized} = \frac{C}{1-\mu} = \frac{\sum_k \left(\frac{\beta_k \bar{x}_k}{\mu}\right) CI_k}{1-\mu} + \frac{GC_\varepsilon/\mu}{1-\mu}$$

As our outcome variable was dichotomous, we used marginal effects obtained from the non- linear logit model in the decomposition analysis to estimate the contributions of the explanatory variables to the C_n. All analyses were conducted using STATA software version 14.

Results

A total of 10,002 adults with a mean age of 47.05 (SD ± 9.02) were included in the analysis, 5,259 (52.58%) of whom were women. Participants belonged to the age group of 35-44 years account for 44.07% of the sample and the majority of them was married (90.18%). Also, the illiterate participants accounted for 35.26% of the whole sample. About 11.74% of the study population practiced dental floss. The proportion of dental flossing was higher in the urban population, higher quintiles of SES, the age group of 34-45 and in participants with university degrees (Tab. I).

The normalized CI was 0.327 for dental flossing in the entire population, 0.323 in the women and 0.329 in the men. The statistically significant positive value of the shows a higher concentration of practice of dental floss among high-SES individuals (Tab. II).

The concentration curve of dental flossing lies below the line of perfect equality, meaning that the practice of dental floss is more concentrated among high-SES individuals. It indicates that there is inequality in the distribution of dental flossing favoring high-SES individuals (Fig. 1).

Tab. I. Prevalence of dental flossing in terms of determinant variables among cohort participants aged 35-65.

Variables	N (%)	Prevalence rate (%)
Sex		
Female	5,259 (52.58)	11.28
Male	4,743 (47.42)	12.25
Age group		
35-44	4,408 (44.07)	17.38
45-54	3,327 (33.26)	10.43
55-65	2,267 (22.67)	2.69
Marital status		
Married	9,020 (90.18)	11.87
Single/divorced/widowed	982 (9.82)	10.49
Education		
Illiterate	4,591 (45.90)	4.77
Primary	2,616 (26.15)	10.86
Intermediate	1,064 (10.46)	17.29
Secondary	968 (9.68)	21.80
Higher	763 (7.63)	36.17
Economic status		
Poorest	2,001 (20.01)	6.20
Second poorest	2,000 (20.00)	7.10
Middle	2,003 (20.03)	8.89
Second richest	1,998 (19.98)	13.81
Richest	2,000 (20.00)	22.70
Place of residence		
Urban	5,916 (59.15)	15.53
Rural	4,086 (40.85)	6.24

Tab. II. Normalized concentration indices (95% Confidence Interval, standard error and p-value) for dental flossing.

Sample		SE	Normalized CI	95% CI	P-value
Total	10,002	0.017	0.327	0.292-0.361	0.000
Male	4,743	0.025	0.329	0.280-0.378	0.000
Female	5,259	0.024	0.323	0.275-0.372	0.000

Fig. 1. Concentration curves of dental flossing among participants of RaNCD cohort study.
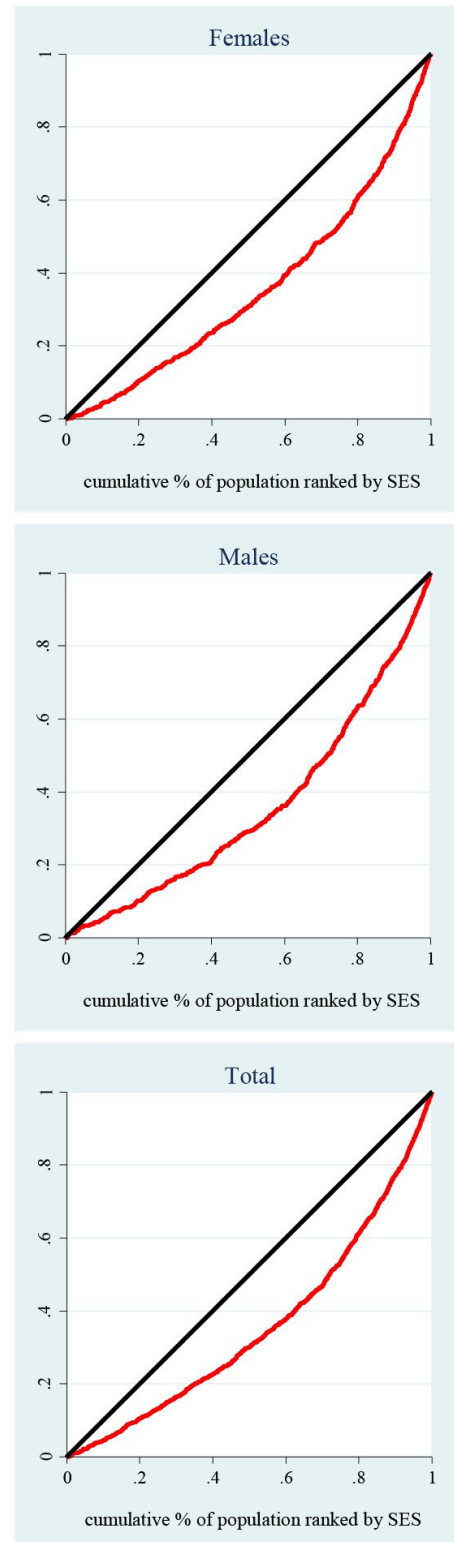
The C for independent variables suggested that women and age group of 55-65 were more concentrated among the low-SES individuals. However, the married and urban participants were more concentrated among high-SES individuals. The decomposition analysis showed that SES (50.58%) and level of education (44.90%) respectively contribute the most to this inequality. The contribution of urban residence and age group in the observed inequalities was 10.55% and 2.70% respectively (Tab. III).

Discussion

In the present study, we measured and decomposed socioeconomic inequalities in dental flossing among adults who participated in RaNCD cohort study, Ravansar, Iran. To the best of the authors' knowledge, no studies have so far been conducted on measuring socioeconomic inequality in the practice of dental floss as a recommended self-care dental practice. We found a prevalence of 11.74% for dental flossing, indicating not satisfactory flossing behavior in the sample. Previous studies [3, 26] also highlighted a poor dental hygiene behavior in Iran. A study on the general population in 2011 with 12,105 individuals reported a prevalence of 16.8% for dental flossing in Iran [3]. In addition to a low prevalence of dental flossing, we found an unequal distribution of the practice of dental floss favoring individuals with higher SES in Ravansar. Previous studies conducted on socioeconomic inequality in oral

health in different countries generally suggest inequality in oral health status and behaviors [27-30]. For example, in line with our findings, a study conducted in Brazil indicated that preventive dental care was more concentrated among high-SES groups [16]. A study in the UK also found an unequal distribution in oral health behaviors favoring high-SES groups [30]. In addition, previous works have shown socioeconomic inequality in the practice of hygiene products such as mouthwashes and toothbrushes as well as receiving dental care [28, 29, 31 32].

The decomposition analysis showed that SES and level of education respectively made the most positive contributions to the socioeconomic inequality in flossing behavior. These results imply that the socioeconomic inequality in dental flossing would have been reduced if these determinants had no impact on oral health behaviors or were equally distributed across the SES groups. In accordance with our results, Asgari et al. found that daily tooth brushing and the practice of dental floss are significantly associated with socioeconomic status [33].

Previous studies also have indicated that SES and level of education are the main contributors to socioeconomic inequalities in oral health and the practice of dental care services [16, 30]. Other main contributors to the observed inequality were the place of residence and older age groups. Some studies have also indicated an association between the area of residence and oral health status [17, 34, 35]. In our sample, rural individuals flossed their teeth less frequently than urban individuals. This rural-urban gap may be due to the fact that rural areas tend to have a large proportion of individuals

Tab. III. Decomposition of concentration index for dental flossing.

	Marginal effects	Elasticity	Ck [1]	Cont. [2]	% Cont. [2]	Summed %
Sex						
Female	0.049	0.222	-0.075	-0.016	-5.1	-5.1
Age group						
35-44						
45-54	-0.032	-0.092	0.041	-0.003	-1.17	2.70
55-65	-0.093	-0.209	-0.070	0.012	3.87	
Marital status						
Married	-0.0007	-0.005	0.026	-0.0001	-0.04	-0.04
Education						
Illiterate						
Primary	0.058	0.131	0.004	0.0005	0.16	44.90
Intermediate	0.124	0.112	0.114	0.013	3.94	
Secondary	0.163	0.134	0.237	0.032	9.79	
Higher	0.251	0.163	0.620	0.101	31.00	
Socioeconomic status						
Poorest						
Second poorest	-0.002	-0.004	-0.453	0.002	0.68	50.58
Middle	0.010	0.018	0.0003	0.000	0.001	
Second richest	0.046	0.078	0.453	0.035	10.89	
Richest	0.082	0.140	0.906	0.127	39.00	
Place of residence						
Urban	0.050	0.252	0.136	0.034	10.55	10.55
Total explained				0.339	103.6	
Residual				-0.011	-3.6	
Total				0.327	100	

[1]: concentration index of each determinants; [2]: contribution of each determinant to the observed inequality.

with lower education levels and those with low SES. In general, having a higher level of education and living in a socioeconomically advantaged area result in further opportunities to adopt healthier habits and benefit from health-promoting behaviors [36, 37]. SES and level of education have remained important issues to consider in formulating policies to reduce inequalities in flossing behavior in developing countries including Iran. Our findings suggest that to address inequalities in dental flossing these factors should be considered in policy interventions. For example, providing special services to individuals of low-SES groups and those with lower educational levels may reduce socioeconomic inequality in flossing behavior. In addition, improving oral health literacy by providing educational programs especially in these groups may be effective in mitigating socioeconomic inequality in the practice of dental floss. The study had some limitations. First, although we used a relatively large sample, the participants were not necessarily representative of Iranian adults. Therefore, further studies on the inequality of flossing behavior at national and subnational levels in Iran are recommended. The cross- sectional nature of the study was another limitation, as it did not show causality. Longitudinal studies are recommended to be designed and conducted in the future to judge the causal relationship.

Conclusions

This study indicated a low prevalence and relatively a high degree of pro-rich inequality in the practice of dental floss among Iranian adults. Socioeconomic status, level of education and place of residence contributed the most to the measured inequality. These factors should be considered in formulating intervention programs.

Ethical statement

The ethics committee of Kermanshah University of Medical Sciences approved the study (Ethics Code: IR.KUMS.REC.1398.327).

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Conflict of interest statement

The authors declare no conflict of interest.

Authors' contributions

MS and FN, contributed to conception and design of the study, analysis and interpretation of the data. MS and FN drafted and critically revised the manuscript. YP, BH and MMN contributed to data collection and critical revision of the manuscript. BKM and HA performed a search of the literature and contributed to critical revision of the manuscript. All authors read and approved the final manuscript.

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