Irritable bowel syndrome is concentrated in people with higher educations in Iran: an inequality analysis

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OBJECTIVES: Like any other health-related disorder, irritable bowel syndrome (IBS) has a differential distribution with respect to socioeconomic factors. This study aimed to estimate and decompose educational inequalities in the prevalence of IBS.

METHODS: Sampling was performed using a multi-stage random cluster sampling approach. The data of 1,850 residents of Kish Island aged 15 years or older were included, and the determinants of IBS were identified using a generalized estimating equation regression model. The concentration index of educational inequality in cases of IBS was estimated and decomposed as the specific inequality index.

RESULTS: The prevalence of IBS in this study was 21.57% (95% confidence interval [CI], 19.69 to 23.44%). The concentration index of IBS was 0.20 (95% CI, 0.14 to 0.26). A multivariable regression model revealed that age, sex, level of education, marital status, anxiety, and poor general health were significant determinants of IBS. In the decomposition analysis, level of education (89.91%), age (−11.99%), and marital status (9.11%) were the three main contributors to IBS inequality. Anxiety and poor general health were the next two contributors to IBS inequality, and were responsible for more than 12% of the total observed inequality.

CONCLUSIONS: The main contributors of IBS inequality were education level, age, and marital status. Given the high percentage of anxious individuals among highly educated, young, single, and divorced people, we can conclude that all contributors to IBS inequality may be partially influenced by psychological factors. Therefore, programs that promote the development of mental health to alleviate the abovementioned inequality in this population are highly warranted.

KEY WORDS: Irritable bowel syndrome, Socioeconomic factors, Inequality, Mental health, Iran
Andrews et al. [7] reported a decreasing trend of IBS prevalence according to income and education from the lowest to the highest groups. Another study also reported that unemployed individuals were more prone to IBS than employed individuals [8].

Despite the well-established diverse distribution of IBS according to socioeconomic status, the determinants of this diversity have not been identified and interpreted using specific inequality indices. Because of the importance of identifying the characteristics of inequalities in IBS, a decomposition analysis of educational inequality, which was the main aim of the present study, might reveal useful information for policymaking. The results of this study are expected to help to make decisions and design programs for alleviating IBS inequality in the future.

MATERIALS AND METHODS

We used data from a household survey on IBS that was conducted on Kish Island in 2009. The large number of islanders visiting Kish Hospital with the chief complaint of psychological and gastrointestinal symptoms justified a survey of the prevalence and familial aggregations of IBS occurrence. In this survey, 2020 people in 343 households were interviewed. A multi-stage cluster sampling method was used for selecting the study participants. More details about the sampling scheme have been published elsewhere [9].

The outcome variable in our study was the presence or absence of IBS, which was measured using the Rome II diagnostic criteria for IBS. This is a widely used tool for the diagnosis of functional bowel disorders and functional abdominal pain. The criteria for IBS diagnosis in this tool include abdominal discomfort or pain that has two of the following three features: 1) relief with defecation, 2) onset associated with a change in stool frequency, and 3) onset associated with a change in the stool form or appearance for at least 12 weeks, not necessarily consecutive, in the preceding 12 months [1].

We excluded people aged 15 years or less from the analysis because of the small number of individuals with IBS in this age group (n = 1); hence, the study sample size dropped to 1,850. To estimate inequality, the level of education (measured as the number of years of education successfully completed) was determined as a proxy for socioeconomic status.

Age, sex, marital status (single, married, or divorced), occupation (housekeeper, unemployed, office worker, self-employed, retired, or student), poor general health measured using the General Health Questionnaire (GHQ) scale (categories: no, GHQ < 24; yes, GHQ > 24; Ebrahimim et al. [10]), anxiety measured using the Beck Anxiety Inventory (BAI) scale (categories: no, BAI < 22; yes, BAI > 22; Beck et al. [11]), history of gastrointestinal disorders (yes/ no), and cigarette smoking status (yes/no) were determined as the study covariates. On the basis of years of education, a new categorical variable referred to as level of education was generated; it had the following categories: primary (<5 years of education), secondary (5-12 years of education), and postsecondary (>12 years of education).

Statistical analysis

Stata version 11/SE (StataCorp., College Station, TX, USA) was used for the analysis. Educational inequality in the cases of IBS was measured using the concentration index. The equation formulated by Kakwani et al. [12] was used to estimate the concentration index, which was calculated as twice the covariance of the health-related outcome variable and the fractional rank in the standard living distribution divided by the mean health-related outcome (equation 1). In this formula, \( \mu \) denotes the health status of the \( i^{th} \) individual, the fractional rank of the \( i^{th} \) individual related to the standard living variable (education in this study), and the average of the outcome variable, respectively. The concentration index varied between -1 and +1, indicating disproportional concentrations of the health outcome among the people with a low or high status of the socioeconomic proxy variable, respectively. The concentration index is 0 when the health outcome has no inequality according to the socioeconomic proxy variable.

\[
C = \frac{2}{\mu} \text{cov}(\mu, r_i) \quad \text{...........(1)}
\]

As our sample consisted of household members, we took into account the cluster sampling effect in the estimation of the concentration index according to the method presented by O’Donnell et al. [13].

Inequality decomposition

For the decomposition of inequality in the outcome variable, we first identified the determinants of the outcome by using a suitable regression model (equation 2).

\[
Y_i = a + \sum_k \beta_k x_{ik} + \epsilon_i \quad \text{...........(2)}
\]

where \( Y_i \), \( \beta_k \), and \( \epsilon_i \) denote the outcome variable, regression coefficient, and the error term, respectively. In its simplest state (with a continuous outcome variable), this will be a linear regression model.

Given that the outcome in our study was a binary variable (yes/no) and our study participants were clustered in families, we used a generalized estimating equation regression model to identify the determinants of IBS.

After identifying the abovementioned determinants, we decomposed the corresponding concentration index according to the approach introduced by Wagstaff et al. [14]; this approach is presented in equation 3:

\[
C = \sum_k \left( \beta_k \frac{\bar{x}_k}{\mu} \right) C_k + \frac{GC}{\mu} \quad \text{...........(3)}
\]

In equation (3), \( \bar{x}_k \), \( C_k \), and \( GC \) denote the mean for the \( k^{th} \) determinant, concentration index for the \( k^{th} \) determinant (defined analogously to the concentration index for the health variable in question), and generalized concentration index for \( i^th \) respectively. More details about concentration index decomposition have been presented elsewhere [13,14].

All participants signed written informed consent forms. The
questionnaires were completely anonymous. The study was approved by the Ethics Committee of Tehran University of Medical Sciences.

RESULTS

The data of 1,850 participants aged 15 years or more were used in the analysis. The mean ± standard deviation of the age and of the years of education was 40.27 ± 15.00 years and 12.60 ± 3.37 years, respectively. The characteristics of the participants are presented in Table 1. As shown, most of the participants were young, female, married, and self-employed, and with secondary education. The frequency of people with anxiety, poor general health, history of gastrointestinal disorders, and history of cigarette smoking was remarkable.

Of the sample, 399 people (21.57%; 95% CI, 19.69 to 23.44) had IBS. The frequency of IBS with respect to the exploratory variables is presented in Table 1. As shown in Table 1, IBS was more prevalent among the age group of 26-50 years; females; divorced and unemployed individuals; people with anxiety, poor general health, and a positive history of gastrointestinal disorders; smokers; and people with postsecondary education.

The concentration index of IBS was 0.20 (95% CI, 0.14 to 0.26). This implies that IBS did not have an equal distribution among people with different levels of education. In other words, persons with IBS were concentrated among people with a relatively high education. Figure 1 depicts the concentration curve for IBS. This curve lies below the equality line, which implies that IBS was more prevalent among people with relatively high education.

The relationship of education with the other variables is presented in Table 2. As shown, the mean of the years of education was higher among people aged 26-50 years, males, single individuals, unemployed individuals, people with anxiety and poor general health, people without a positive history of gastrointestinal disorders, and cigarette smokers. Among these variables, only sex and history of gastrointestinal disorders did not have a statistically significant relationship with education.

We identified the determinants of IBS by using a generalized estimating equation regression model as a primary step for the IBS educational inequality decomposition. We used the forward strategy, introduced by Hosmer & Lemeshow [15], for building the model. A significance level of 0.20 and 0.05 was considered for the univariate and multivariate analysis, respectively. The vari-

Table 1. Socio-demographic characteristics of Kish residents aged 15 years and above and prevalence of irritable bowel syndrome (IBS) in terms of these characteristics in 2009

| Variable                                | n (%) | IBS distribution | p-value |
|-----------------------------------------|-------|------------------|---------|
| Age (yr)                                |       |                  |         |
| 15-25                                   | 395 (21.35) | 65 (16.46) | <0.001 |
| 26-50                                   | 989 (53.46) | 230 (23.26) |         |
| 51 or older                             | 466 (25.19) | 104 (22.32) |         |
| Sex                                     |       |                  |         |
| Male                                    | 882 (47.68) | 140 (15.87) | <0.001 |
| Female                                  | 952 (51.46) | 258 (27.10) |         |
| Unknown                                 | 16 (0.86) | 1 (6.25) |         |
| Marital status                          |       |                  |         |
| Single                                  | 544 (29.41) | 146 (26.84) | <0.001 |
| Married                                 | 1,231 (66.54) | 227 (18.44) |         |
| Divorced                                | 75 (4.05) | 26 (34.67) |         |
| Job status                              |       |                  |         |
| Housekeeper                             | 329 (17.78) | 83 (25.23) | 0.004  |
| Unemployed                              | 267 (14.43) | 73 (27.34) |         |
| Office worker                           | 303 (16.38) | 57 (18.81) |         |
| Self-employed                           | 564 (30.49) | 117 (20.74) |         |
| Retired                                 | 93 (5.03) | 20 (21.51) |         |
| Student (school or university)          | 263 (14.22) | 38 (14.45) |         |
| Unknown                                 | 31 (1.68) | 11 (35.48) |         |
| Anxiety (BAI ≥22)                       |       |                  |         |
| Yes                                     | 218 (11.78) | 123 (56.42) | <0.001 |
| No                                      | 1,572 (84.97) | 266 (16.92) |         |
| Unknown                                 | 60 (3.24) | 10 (16.67) |         |
| Poor general health (GHQ ≥24)           |       |                  |         |
| Yes                                     | 121 (6.54) | 83 (68.60) | <0.001 |
| No                                      | 1,668 (90.16) | 306 (18.53) |         |
| Unknown                                 | 61 (3.30) | 10 (16.39) |         |
| History of gastrointestinal disorders    |       |                  |         |
| Yes                                     | 214 (11.57) | 107 (50.00) | <0.001 |
| No                                      | 1,632 (88.22) | 292 (18.89) |         |
| Unknown                                 | 4 (0.22) | 0 (0.00) |         |
| Cigarette smoking                       |       |                  |         |
| Yes                                     | 463 (25.03) | 115 (24.84) | 0.05   |
| No                                      | 1,387 (74.97) | 284 (20.48) |         |
| Level of education (yr)                 |       |                  |         |
| Primary (≤5)                            | 103 (5.57) | 19 (18.45) | <0.001 |
| Secondary (6-12)                        | 1,010 (54.59) | 142 (14.06) |         |
| Academic (>12)                          | 737 (39.84) | 238 (32.29) |         |

BAI, Beck Anxiety Inventory score; GHQ, General Health Questionnaire score.

Figure 1. Concentration curve for irritable bowel syndrome (IBS) on Kish Island, 2009.
| Variable                          | Mean   | SD    | p-value |
|----------------------------------|--------|-------|---------|
| Age (yr)                         |        |       |         |
| 15-25                            | 13.13  | 2.31  | <0.001  |
| 26-50                            | 13.49  | 2.66  |         |
| 51 or older                      | 10.28  | 4.28  |         |
| Sex                              |        |       |         |
| Male                             | 12.67  | 3.23  | 0.44\(^2\) |
| Female                           | 12.55  | 3.51  |         |
| Marital status                   |        |       |         |
| Single                           | 13.61  | 2.56  | <0.001  |
| Married                          | 12.23  | 3.47  |         |
| Divorced                         | 11.51  | 4.87  |         |
| Job status                       |        |       |         |
| Housekeeper                      | 12.20  | 3.45  | <0.001  |
| Unemployed                       | 13.83  | 2.69  |         |
| Office worker                    | 12.84  | 2.92  |         |
| Self-employed                    | 12.59  | 3.28  |         |
| Retired                          | 9.45   | 4.73  |         |
| Student (school or university)   | 12.55  | 3.28  |         |
| Anxiety (BAI ≥22)                |        |       |         |
| Yes                              | 13.32  | 3.28  | 0.02\(^2\) |
| No                               | 12.80  | 2.95  |         |
| Poor general health (GHQ ≥24)    |        |       |         |
| Yes                              | 13.62  | 3.34  | 0.004\(^2\) |
| No                               | 12.81  | 2.96  |         |
| History of gastrointestinal disorders | 12.30  | 4.11  | 0.16\(^2\) |
| Yes                              | 12.65  | 3.26  |         |
| No                               | 12.47  | 3.31  |         |

SD, standard deviation; BAI, Beck Anxiety Inventory score; GHQ, General Heath Questionaire score.
\(^1\)One-way analysis of variance test.
\(^2\)Independent t-test.

In comparison to some other studies in Iran, this study demonstrated a higher prevalence of IBS [2,16]. This could be attributed to the specific conditions of life of the Kish Islanders. As mentioned before, a remarkable proportion of participants had anxiety, which has been identified as a risk factor for IBS [17]. The islanders are exposed to various stressors such as long working hours and a lack of stable jobs. According to a study, the assignment of most employment with economic and cultural potential to non-natives on Kish Island can cause depression and anxiety in the local people [18]. Another probable cause is diet. Khayyatadzeh et al. [19] reported that dietary patterns were an effective factor for alleviating or aggravating the symptoms of IBS. They implied that a vegetarian diet helped to decrease the risk of IBS in Iranian adults. Although we did not assess the dietary patterns of the participants in this study, given that the island does not have a conducive environment for agriculture, the limited access of residents to adequate amounts of fresh fruits and vegetables could be another explanation for the high prevalence of IBS in this region. In addition, the participants in this study were often family members. Multiple studies have shown that the presence of an individual with IBS in a family significantly increases the risk of IBS in the other family members [20-23]. Therefore, another reason for the high prevalence of IBS in our study could be the statistically significant familial aggregation due to our sampling type.

The concentration index and the concentration curve for educational inequality in cases of IBS demonstrated that IBS was significantly concentrated in people with relatively high education. In the decomposition analysis, most determinants showed a positive contribution to the educational inequality in cases of IBS. This implies that this determinant helped to increase the IBS inequality to disfavor people with relatively high education. A negative contribution, on the other hand, implies that the variable contributed to the alleviation of the IBS inequality in favor of relatively highly educated people.

The contributors of this inequality, from the most to the least important, included education, age, marital status, anxiety, general health status, sex, and a history of gastrointestinal disorders.

As mentioned earlier, the main contributor to this inequality was education. According to some studies, IBS has an inverse re-
Table 3. Adjusted determinants of irritable bowel syndrome and decomposition of its concentration index in Kish residents aged 15 years and above in 2009

|                              | Coefficient | Mean | Elasticity | CI       | Contribution (%) |
|------------------------------|-------------|------|------------|----------|------------------|
| **Age (yr)**                 |             |      |            |          |                  |
| 15-25 Reference              |             |      |            |          |                  |
| 26-50                        | 0.762       | 0.53 | -0.295     | 0.133    | 19.10            |
| 51 or older                  | 1.060       | 0.25 | -0.193     | -0.331   | -31.09           |
| Total                        |             |      |            |          | -11.99           |
| **Sex**                      |             |      |            |          |                  |
| Male Reference               |             |      |            |          |                  |
| Female                       | 0.793       | 0.52 | -0.298     | 0.003    | 0.49             |
| **Marital status**           |             |      |            |          |                  |
| Married Reference            |             |      |            |          |                  |
| Single                       | 0.563       | 0.29 | -0.120     | 0.173    | 10.09            |
| Divorced                     | 0.742       | 0.04 | -0.022     | -0.092   | -0.98            |
| Total                        |             |      |            |          | 9.11             |
| **Anxiety (BAI ≥ 22)**       |             |      |            |          |                  |
| No Reference                 |             |      |            |          |                  |
| Yes                          | 1.206       | 0.12 | -0.106     | 0.120    | 6.22             |
| **Poor general health (GHQ ≥ 24)** |         |      |            |          |                  |
| No Reference                 |             |      |            |          |                  |
| Yes                          | 1.605       | 0.07 | -0.078     | 0.152    | 5.83             |
| **History of gastrointestinal disorders** |       |      |            |          |                  |
| No Reference                 |             |      |            |          |                  |
| Yes                          | 1.393       | 0.12 | -0.117     | 0.007    | 0.43             |
| **Level of education (yr)**  |             |      |            |          |                  |
| Primary (≤ 5)                |             |      |            |          |                  |
| Secondary (6-12)             | -1.335      | 0.06 | 0.054      | -0.943   | 24.64            |
| Academic (>12)               | -0.993      | 0.55 | 0.393      | -0.342   | 65.27            |
| Total                        |             |      |            |          | 89.91            |

CI, concentration index; BAI, Beck Anxiety Inventory score; GHQ, General Health Questionnaire score.

Table 4. Number and percentage of people with anxiety and poor general health by the 3 main contributors to IBS inequality among Kish residents aged 15 years and above in 2009

|                              | Total (n) | Anxiety (BAI ≥ 22) | Poor general health (GHQ ≥ 24) |
|------------------------------|-----------|--------------------|---------------------------------|
|                              | n | % | p-value | n | % | p-value |
| **Level of education (yr)**  |   |   |         |   |   |         |
| Primary (≤ 5)                | 103| 9 | 13.64 | 0.001 | 5 | 7.58 | 0.001 |
| Secondary (6-12)             | 1,010| 95 | 9.62 |        | 48 | 4.86 |        |
| Academic (>12)               | 737| 114 | 15.49 |        | 68 | 9.25 |        |
| **Age (yr)**                 |   |   |         |   |   |         |
| 15-25                        | 395| 39 | 10.05 | 0.14 | 23 | 5.94 | 0.12 |
| 26-50                        | 989| 117 | 11.98 |        | 60 | 6.14 |        |
| 51 or older                  | 466| 62 | 14.59 |        | 38 | 8.94 |        |
| **Marital status**           |   |   |         |   |   |         |
| Married                      | 544| 122 | 10.23 | 0.002 | 62 | 5.20 | 0.001 |
| Single                       | 1,231| 87 | 16.23 |        | 51 | 9.51 |        |
| Divorced                     | 75 | 9 | 7.40 |        | 8 | 13.11 |        |

IBS, irritable bowel syndrome; BAI, Beck Anxiety Inventory score; GHQ, General Health Questionnaire score.
As the relationship between mental health and IBS has been confirmed by multiple studies [30], we recommend setting up programs with the aim of reducing anxiety and promoting mental health in Kish Islanders, particularly the highly educated, to help decrease the educational inequality in cases of IBS.

A minor contributor to IBS inequality was sex. Being female was associated with a higher risk of IBS. This finding has been reported by multiple studies [30,32-34]. Pan et al. [33] attributed this sex difference to female hormones as a result of the declining incidence of IBS in females after menopause. Chang & Heitkemper [34] reported that sex-related differences in gastrointestinal transit time, visceral sensitivity, central nervous system pain processing, neuroendocrine, autonomic nervous system, and stress reactivity can justify the predominance of IBS in females. In contrast, Farzaneh et al. [8] stated this difference to be a result of a selection bias due to a higher likelihood of seeking healthcare in females.

A positive history of gastrointestinal disorders was the most minor contributor to IBS inequality in this study. Ansari et al. [35] reported that people with ulcerative colitis had a higher risk of developing IBS than healthy controls. According to a review article, a conclusive relationship was found between previous bowel disorders and IBS occurrence [36].

Occupation had a statistically significant relationship with IBS in the univariate analysis. As mentioned earlier, the prevalence of IBS was higher in unemployed people. Modabbernia et al. [17] found a significantly higher frequency of IBS in jobless people than in others. Farzaneh et al. [8] reported that lower income and severe psychological distress in unemployed people made them more prone to having IBS than employed individuals.

Although IBS prevalence was significantly higher in smokers, we did not find any statistically significant relationship between smoking and IBS in the multivariable analysis. This finding is consistent with the reports of the previous studies [25,32].

Strengths and limitations

To the best of our knowledge, this is the first study that conducted an inequality analysis of IBS. In this study, a large-scale population-based sampling enabled us to obtain highly precise results. However, this study had some limitations. As mentioned, the proxy variable of socioeconomic status was needed to estimate and decompose inequality. In this study, proxy variables for the standard of living, such as income and wealth status, were not measured. People’s reluctance to disclose information related to their income as a result of concerns related to tax payments and income fluctuations due to the seasonality of jobs were the main obstacles to asking questions about income in this region. Therefore, education was the only variable associated with socioeconomic status in our data. Education alone may not be a comprehensive indicator of socioeconomic status. Therefore, we suggest an assessment of IBS inequality with respect to other indicators of socioeconomic status, particularly wealth, in the future.

As another weakness, the study participants were family mem-
bers. Therefore, our estimations may slightly differ from those of studies with independent participants. On the other hand, Yeng-prugsawan et al. [37] demonstrated that generalized linear models with a binomial distribution and an identity link function are a suitable choice for decomposition analysis when the outcome variable is binary because of the estimates of determinants that are unchangeable with respect to the choice of reference group. However, we could not use this model for the decomposition analysis as a result of the correlated outcome and the failure of the independence assumption. Therefore, we recommend an assessment of IBS inequalities in an independent, large sample in future studies.

In conclusion, we showed that IBS demonstrated statistically significant educational inequality, with a disproportional concentration in highly educated persons. The most important contributors to this inequality were education, age, and marital status. Given the high percentage of anxious individuals among highly educated, young, single, and divorced people, we can conclude that all contributors to IBS inequality may be partially influenced by psychological factors. We recommend developing anxiety reduction and mental health promotion programs for the people of Kish Island as a helpful solution to alleviate the unequal distribution of IBS.

CONFLICT OF INTEREST

The authors have no conflicts of interest to declare for this study.

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