Association of Cardio-Metabolic Risk Factors and Basic and Instrumental Activities of Daily Living Among Elderly People; Bushehr Elderly Health Program

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Research article

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Abstract

**Background:** Iran’s population is aging. One of the most common problems in Iranian public health is the high prevalence of cardio-metabolic risk factors. The purpose of this study was to investigate the relationship between cardio-metabolic and demographic risk factors and disability in people 60 years and older in Iran.

**Methods:** Data from the Bushehr Elderly Health (BEH) program was used in the analysis. Demographic characteristics, as well as the history of diabetes and other chronic diseases, and smoking were measured using standardized questionnaires. Anthropometric measurements and laboratory tests were performed under standard conditions. Dependency was determined by the questionnaires of basic activities of daily living (BADL) and instrumental activities of daily living (IADL) using Barthel and Lawton scales respectively. Multiple logistic regression was used in the analysis.

**Results:** Mean (Standard Deviation) of the participants’ age was 69.34 (6.4) years (range: 60 and 96 years), and 48.06% of the participants were men. After adjusting for potential confounders, being older, being female (OR (95%CI): 2.33 (1.89 - 2.86)), having a lower education level, a history of diabetes mellitus (OR: 1.43 (1.17 -1.74)) and past smoking (OR: 1.25 (1.00 - 1.55)), and no physical activity (OR: 1.54 (1.23 - 1.87)) were significantly associated with dependency in IADL. Also, being older and female (OR: 2.38 (1.85 - 3.03)), having a lower education level, no physical activity (OR: 2.17 (1.61 - 2.86)) and low daily intake of calories were associated with dependency in BADL.

**Conclusion:** Age, gender, education level and physical activity are risk factors of the dependency in both of BADL and IADL in the elderly people. Diabetes mellitus and past smoking are risk factors of the dependency in IADL, and low HDL cholesterol and low daily intake of calories are risk factors of the dependency in BADL.

Background

According to the International Classification of Functioning, Disability, and Health (ICF), disability is defined as disorders and limitations of activity and participation. Disability is the result of an interaction between illness and personal and environmental factors (e.g., negative attitudes, inability to use the transportation system and inadequate public facilities, and inadequate social support) (1). The Barthel activities of daily living (ADL) and the Lawton instrumental activities of daily living (IADL) indices are standard tools for measuring disability (2, 3). During recent years, the burden of disability increased by 52% worldwide. Almost 80% of these disabilities are the result of non-communicable diseases. According to the Global Burden of Disease (GBD), diabetes was the fourth leading cause of disability in the world in 2017 (4).

Disability risk factors vary across communities and regions of the world. According to a study in Australia, disability was positively associated with smoking, obesity, diabetes and being women (5). In another study in Netherlands, the most important predictors of disability in old age were previous
disability and age. Other factors (such as gender, cognitive function, peer health score, obesity, hypertension, and joint pain) did not play a significant role in increasing disability (6). In another study conducted in 6 middle and low-income countries (India, Ghana, South Africa, Mexico, Russia, and China), age, chronic diseases (such as hypertension, angina, stroke, diabetes, chronic lung disease, asthma, and arthritis) and depression were identified as the most important factors affecting disability. Other factors (such as gender, marital status, education, social capital, physical activity, BMI) either had no role or played a different role in societies (7).

In a study of the elderly in Spain, the hazard ratios (HRs) in the physical disability domain questionnaire were 1.14 to 1.52 for total mortality and 1.29 to 1.58 for cardiovascular diseases (CVD) compared to people with no disabilities. The researchers found that in the elderly with disabilities, physical activity reduces the risk of total death as well as death from CVD. The death rate in disabled people is similar to inactive people with no disability. The suggested mechanism is physical activity reduces obesity, sarcopenia, falls and more. Physical activity also improves one's social network, mood, and depression; all of them are associated with reduced morbidity and mortality (8).

Dhamoon et al. showed that although the maximum rate of disability due to stroke and myocardial infarction (MI) occurs during the stroke, the rate of disability continues to increase annually in people who experience these vascular events. This is even worse in people who have had a stroke. (9). Therefore, if the disability status is determined using self-report, it may consider the timing of the underlying disease.

Iranian population has quadrupled over the last six decades, while population growth has almost halved (10). Also, from 1970 to 2010, life expectancy increased from 50.6 to 71.6 years for Iranian men and from 56.2 to 77.8 years for women. Iran is one of the countries that during this period has experienced significant improvements in life expectancy at birth in both sexes (11). One of the most common problems in Iranian public health is the high prevalence of cardio-metabolic risk factors. For example, the results of a meta-analysis showed that about one-third of Iranians had metabolic syndrome. Besides, the prevalence of this syndrome increases with age (12). According to Sadeghi et al., only due to aging, the CVD burden and DALY in the Iranian population will double in 2025 compared to 2005 (13). The highest YLL, YLD, and DALY will be in people over 80 years of age (14). The purpose of this study was to investigate the relationship between cardio-metabolic and demographic risk factors and disability using basic and instrumental activities of daily living, in people 60 years and older in Iran.

**Methods**

**Study design**

In this study, a total of 2426 people from the second stage of the first phase of a population-based prospective cohort study, the Bushehr Elderly Health (BEH) program (15, 16) were included in the analysis. The purpose of the BEH study, whose methodology has been described elsewhere (15, 16), is to investigate the prevalence of non-communicable diseases and associated risk factors among people
60 years and older. The participants were selected through multi-stage stratified cluster random sampling in Bushehr, southern Iran (15). The first stage of the first phase of the BEH program was implemented from March 2013 to October 2014. Prevalence of cardiovascular risk factors investigated among 3000 men and women (participation rate = 90.2%) in this stage (15). The second stage of the first phase of the study was conducted 2.5 years later on 2772 eligible persons from the first stage. The prevalence of musculoskeletal and cognitive diseases and their risk factors was investigated in this stage (16).

**Data collection**

In this study, disability was measured by two questionnaires of Basic Activity of Daily Living (BADL) using Barthel scale(3), and Instrumental Activity of Daily Living (IADL) using Lawton (2) scale, through face to face interview with the participants by the trained questioners. The validity and reliability of these questionnaires were previously assessed in Iran and were at acceptable levels (17, 18). The BADL questionnaire has 10 items including eating, bathing, urine control, toilet use, moving from bed to chair and vice versa, dressing, self-cleaning, stool control, climbing stairs, and ability to move on a flat surface. The IADL questionnaire has 8 items including the ability to use the phone, cooking meals, washing clothes, taking medication, shopping, housekeeping, transportation, and financial ability. These two questionnaires assess the degree of dependency of the elderly. In the BADL questionnaire, the subjects with total scores of < 95 of the Barthel scale were considered as dependent, and those with scores of 95 to 100 were considered as independent. The subjects with total scores of 0 to 7 of the IADL questionnaire were also defined as dependent and those with score of 8 were defined as independent.

Demographic characteristics including sex, age, marital status, and education level, as well as information on cardio-metabolic risk factors including history of diabetes mellitus and hypertension, smoking, physical activity, and daily intake of calories, were collected using the standardized questionnaires. Anthropometric measurements including height, weight, and waist circumference as well as laboratory measurements including LDL, HDL, total cholesterol and triglyceride were performed under standard conditions with calibrated instruments. The definition of the independent variables has been presented in Table 1.
Table 1
Definition of the study explanatory variables

| Variable                        | Definition                                                                                                                                 |
|---------------------------------|------------------------------------------------------------------------------------------------------------------------------------------|
| Diabetes mellitus               | Current fasting blood sugar $\geq 126$ mg/dL or HbA1c $\geq 6.5$, or subject’s self-reporting of diabetes mellitus based on a doctor’s diagnosis, or current use of anti-diabetic drugs |
| Hypertension                    | Current systolic blood pressure $\geq 140$ mmHg or diastolic blood pressure $\geq 90$ mmHg, or subject’s self-reporting of hypertension based on a doctor’s diagnosis, or current use of anti-hypertension drugs |
| High total cholesterol          | Total cholesterol $\geq 200$ mg/dL                                                                                                        |
| Low HDL cholesterol             | High Density Lipoprotein cholesterol $< 40$ mg/dL in males, and $< 50$ mg/dL in females                                                  |
| High LDL cholesterol            | Low Density Lipoprotein cholesterol $\geq 110$ mg/dL                                                                                        |
| High serum triglyceride         | Serum triglyceride $\geq 150$ mg/dL                                                                                                       |
| Smoking                         | Cigarettes or hookahs\(^a\) or pipes use                                                                                                  |
| High Waist Circumference        | Waist Circumference $\leq 102$ cm in males and $\leq 88$ cm in females                                                                      |
| Physical Activity               | Measured using Aadahl et al. physical activity questionnaire (29)                                                                           |
| Daily intake of calories (Kcal) | Assessed by a standardized 24-hour dietaryrecall questionnaire                                                                            |

\(^a\): a single- or multi-stemmed instrument for vaporizing and smoking flavored tobacco, whose vapor or smoke is passed through a water basin—often glass-based—before inhalation.

Table 1
Statistical analysis:

In the descriptive analysis, we used the mean (standard deviation), and number (percent) for the continuous and categorical variables respectively. In the analytic analysis, at first, the directed acyclic graph (DAG) was depicted based on the literature review, considering the activities of daily living as the outcome and the cardio-metabolic and demographic risk factors as the explanatory variables. The logistic regression model via Hosmer and Lemeshow suggested strategy (19) was used to investigate the association between BADL and IADL and cardio-metabolic and demographic risk factors based on the causal graph. The risk factors that their effect should be controlled based on the DAG, as well as the P-value of their association with the outcome was $\leq 0.25$ in the bivariate analysis were entered into the multiple logistic model. Then the included risk factors removed from the model one by one when they lost their significance while checking via a likelihood ratio test. Afterward, the statistical significance of the
plausible interaction terms between the remaining risk factors in the model was assessed. No interaction term was statistically significant. Eventually, the goodness of fit of the final model to the data was checked out using the Hosmer-Lemeshow test and the receiver operating characteristic (ROC) curve. Stata version 15.1 and R software version 3.6.1 (20) were used for statistical analysis.

Results:

Mean (Standard Deviation) of the participants’ age was 69.3 (6.4) years (range: 60 and 96 years). 76.8% of the participants were married. About 67% of people were literate. The demographic characteristics of the participants were presented in Table 2.

| Characteristic       | No. (%)      |
|----------------------|--------------|
| Men                  | 1166 (48.06) |
| Age (years)          |              |
| 60–64                | 598 (24.65)  |
| 65–69                | 952 (39.24)  |
| 70–74                | 379 (15.62)  |
| 75–79                | 282 (11.62)  |
| 80–84                | 146 (6.02)   |
| ≥ 85                 | 69 (2.84)    |

Marital status

| Characteristic     | No. (%)  |
|--------------------|----------|
| Single             | 19 (0.78) |
| Married            | 1864 (76.83) |
| Divorced           | 20 (0.82) |
| Widow              | 523 (21.56) |

Education

| Characteristic      | No. (%)  |
|---------------------|----------|
| No education        | 800 (32.98) |
| Primary School      | 885 (36.48) |
| Guidance school     | 218 (8.99)  |
| High school         | 332 (3.69)  |
| Academic            | 189 (7.79)  |
In all, 1235 out of 2179 (proportion (95% CI); 56.68 (54.58–58.75) %), and 560 out of 2381 of the study participants (proportion (95% CI); 23.52 (21.86–25.27) %) were dependent in the IADL and BADL, respectively.

Mean (Standard Deviation) of the age of dependent and independent people in the IADL were 70.26 (6.86) and 67.65 (4.98) years respectively. Table 3 presents the association between the demographic and cardio-metabolic risk factors with dependency in the IADL using simple and multiple logistic regressions. Estimates of the prevalence odds ratio of each risk factor were adjusted for other risk factors entered into the multiple logistic regression model. The p-value of Hosmer and Lemeshow goodness of fit (GOF) test for the IADL multiple logistic model was 0.05. The ROC curve reflecting the discrimination power of the multiple logistic model for IADL has been presented in Fig. 1. The area under the curve (AUC) of it was 0.74.
Table 3
Assessment of the association between the cardio-metabolic and demographic risk factors and dependency in the IADL using simple and multiple logistic regressions

| Risk Factor                  | Dependent No. (%) | Crude POR\(^a\) (95%CI) | P value\(^b\) | Adjusted POR (95%CI) | P value\(^c\) |
|------------------------------|-------------------|--------------------------|---------------|----------------------|---------------|
| **Age (years)**              |                   |                          |               |                      |               |
| 60–64                        | 267 (48.46)       | 1                        | -             | 1                    | -             |
| 65–69                        | 453 (52.31)       | 1.17 (0.94–1.44)         | 0.16          | 1.05 (0.83–1.32)     | 0.70          |
| 70–74                        | 196 (57.48)       | 1.44 (1.09–1.89)         | 0.009         | 1.28 (0.95–1.72)     | 0.10          |
| 75–79                        | 172 (70.2)        | 2.51 (1.82–3.45)         | <0.001        | 1.88 (1.32–2.67)     | <0.001        |
| 80–84                        | 100 (80.65)       | 4.43 (2.75–7.13)         | <0.001        | 3.49 (2.09–5.82)     | <0.001        |
| ≥ 85                         | 47 (90.38)        | 10.00 (3.92–25.52)       | <0.001        | 6.61 (2.52–17.34)    | <0.001        |
| **Sex**                      |                   |                          |               |                      |               |
| Female                       | 817 (68.95)       | 1                        | -             | 1                    | -             |
| Male                         | 418 (42.05)       | 0.33 (0.27–0.39)         | <0.001        | 0.43 (0.35–0.53)     | <0.001        |
| **Education**                |                   |                          |               |                      |               |
| No education                 | 533 (75.07)       | 1                        | -             | 1                    | -             |
| Primary School               | 465 (58.56)       | 0.47 (0.38–0.58)         | <0.001        | 0.64 (0.51–0.81)     | <0.001        |
| Guidance school              | 81 (40.91)        | 0.23 (0.16–0.32)         | <0.001        | 0.37 (0.26–0.52)     | <0.001        |
| High school                  | 103 (34.33)       | 0.17 (0.13–0.23)         | <0.001        | 0.32 (0.23–0.44)     | <0.001        |
| Academic                     | 53 (29.94)        | 0.14 (0.10–0.20)         | <0.001        | 0.30 (0.20–0.45)     | <0.001        |
| **Diabetes mellitus**        |                   |                          |               |                      |               |
| No                           | 770 (53.44)       | 1                        | -             | 1                    | -             |
| Yes                          | 462 (63.03)       | 1.49 (1.24–1.78)         | <0.001        | 1.43 (1.17–1.74)     | <0.001        |
| **Hypertension**             |                   |                          |               |                      |               |
| No                           | 294 (50.6)        | 1                        | -             | -                    | -             |

\(a\): Prevalence Odds Ratio  
\(b\): In the bivariate analysis  
\(c\): In the multiple logistic regression  
\(d\): Mean (Standard Deviation)
| Risk Factor                        | Dependent No. (%) | Crude POR\(^a\) (95%CI) | P value\(^b\) | Adjusted POR (95%CI) | P value\(^c\) |
|-----------------------------------|-------------------|---------------------------|---------------|-----------------------|---------------|
| **High total cholesterol**        |                   |                           |               |                       |               |
| No                                | 825 (56.12)       | 1                         | -             | -                     | -             |
| Yes                               | 409 (57.77)       | 1.07 (0.89–1.28)          | 0.47          | -                     | -             |
| **Low HDL cholesterol**           |                   |                           |               |                       |               |
| No                                | 577 (52.22)       | 1                         | -             | -                     | -             |
| Yes                               | 657 (61.23)       | 1.44 (1.22–1.71)          | < 0.001       | -                     | -             |
| **High LDL cholesterol**          |                   |                           |               |                       |               |
| No                                | 643 (56.9)        | 1                         | -             | -                     | -             |
| Yes                               | 591 (56.45)       | 0.98 (0.83–1.16)          | 0.83          | -                     | -             |
| **High serum triglyceride**       |                   |                           |               |                       |               |
| No                                | 841 (56.56)       | 1                         | -             | -                     | -             |
| Yes                               | 393 (56.87)       | 1.01 (0.84–1.21)          | 0.89          | -                     | -             |
| **Smoking**                       |                   |                           |               |                       |               |
| Never                             | 525 (53.9)        | 1                         | -             | 1                     | -             |
| Past                              | 476 (63.21)       | 1.47 (1.21–1.78)          | < 0.001       | 1.25 (1.00–1.55)      | 0.047         |
| Current                           | 234 (51.77)       | 0.92 (0.73–1.15)          | 0.45          | 0.83 (0.64–1.06)      | 0.14          |
| **BMI**                           |                   |                           |               |                       |               |
| < 18.5                            | 24 (57.14)        | 1                         | -             | -                     | -             |
| 18.5–24.9                         | 352 (56.23)       | 0.96 (0.51–1.81)          | 0.91          | -                     | -             |
| 25-29.9                           | 496 (53.10)       | 0.85 (0.45–1.59)          | 0.61          | -                     | -             |
| ≥ 30                              | 363 (62.91)       | 1.27 (.67–2.40)           | 0.46          | -                     | -             |
| **High Waist Circumference**      |                   |                           |               |                       |               |
| No                                | 417 (56.28)       | 1                         | -             | -                     | -             |
| Yes                               | 818 (56.88)       | 1.02 (0.86–1.23)          | 0.79          | -                     | -             |

a: Prevalence Odds Ratio
b: In the bivariate analysis
c: In the multiple logistic regression
d: Mean (Standard Deviation)
| Risk Factor            | Dependent No. (%) | Crude POR<sup>a</sup> (95% CI) | P value<sup>b</sup> | Adjusted POR (95% CI) | P value<sup>c</sup> |
|------------------------|-------------------|---------------------------------|---------------------|------------------------|---------------------|
| Physical Activity      |                   |                                 |                     |                        |                     |
| No                     | 993 (60.18)       | 1                               | -                   | 1                      | -                   |
| Yes                    | 242 (45.75)       | 0.56 (0.46–0.68)                | < 0.001             | 0.65 (0.53–0.81)       | < 0.001             |
| Daily intake of calories | 1533.96 (582.38)<sup>d</sup> | .9996 (.9995–.9998) | < 0.001             | -                      | -                   |

<sup>a</sup> Prevalence Odds Ratio  
<sup>b</sup> In the bivariate analysis  
<sup>c</sup> In the multiple logistic regression  
<sup>d</sup> Mean (Standard Deviation)

Table 3

Figure 1

Mean (Standard Deviation) of the age of dependent and independent participants in the BADL were 71.33 (7.28) and 68.72 (5.99) years, respectively. The association between the demographic and cardiometabolic risk factors with dependency in the BADL has been presented in Table 4. Figure 2 presents the ROC curve reflecting the discrimination power of the multiple logistic model for BADL with AUC = 0.72. Result of the Hosmer and Lemeshow GOF test for the BADL multiple logistic model was not statistically significant (P-value = 0.06).
Table 4
Assessment of the association between the cardio-metabolic and demographic risk factors and dependency in the BADL using simple and multiple logistic regressions

| Risk Factor          | Dependent No. (%) | Crude POR\(^a\) (95%CI) | P value\(^b\) | Adjusted POR (95%CI) | P value\(^c\) |
|----------------------|------------------|-------------------------|-------------|----------------------|-------------|
| **Age (years)**      |                  |                         |             |                      |             |
| 60–64                | 98 (16.64)       | 1                      | -           | 1                    | -           |
| 65–69                | 191 (20.45)      | 1.29 (0.98–1.68)       | 0.06        | 1.15 (0.87–1.53)     | 0.33        |
| 70–74                | 95 (25.61)       | 1.72 (1.25–2.37)       | 0.001       | 1.60 (1.14–2.24)     | 0.007       |
| 75–79                | 101 (36.33)      | 2.86 (2.06–3.96)       | <0.001      | 2.36 (1.65–3.38)     | <0.001      |
| 80–84                | 39 (27.86)       | 1.93 (1.26–2.97)       | 0.003       | 1.51 (0.95–2.41)     | 0.078       |
| ≥ 85                 | 36 (52.17)       | 5.47 (3.25–9.19)       | <0.001      | 4.00 (2.29–6.98)     | <0.001      |
| **Sex**              |                  |                         |             |                      |             |
| Female               | 405 (32.85)      | 1                      | -           | 1                    | -           |
| Male                 | 155 (13.5)       | 0.32 (0.26–0.39)       | <0.001      | 0.42 (0.33–0.54)     | <0.001      |
| **Education**        |                  |                         |             |                      |             |
| No education         | 268 (34.4)       | 1                      | -           | 1                    | -           |
| Primary School       | 204 (23.34)      | 0.58 (0.47–0.72)       | <0.001      | 0.84 (0.67–1.07)     | 0.154       |
| Guidance school      | 37 (17.21)       | 0.40 (0.27–0.58)       | <0.001      | 0.76 (0.51–1.15)     | 0.20        |
| High school          | 35 (10.74)       | 0.23 (0.16–0.33)       | <0.001      | 0.48 (0.32–0.72)     | <0.001      |
| Academic             | 16 (8.56)        | 0.18 (0.10–0.30)       | <0.001      | 0.46 (0.26–0.82)     | 0.008       |
| **Diabetes mellitus**|                  |                         |             |                      |             |
| No                   | 355 (22.4)       | 1                      | -           | -                    | -           |
| Yes                  | 204 (25.79)      | 1.20 (0.99–1.47)       | 0.07        | -                    | -           |
| **Hypertension**     |                  |                         |             |                      |             |
| No                   | 125 (19.5)       | 1                      | -           | -                    | -           |

\(\text{a: Prevalence Odds Ratio}\)

\(\text{b: In the bivariate analysis}\)

\(\text{c: In the multiple logistic regression}\)

\(\text{d: Mean (Standard Deviation)}\)
| Risk Factor                        | Dependent No. (%) | Crude POR<sup>a</sup> (95%CI) | P value<sup>b</sup> | Adjusted POR (95%CI) | P value<sup>c</sup> |
|-----------------------------------|-------------------|-------------------------------|---------------------|----------------------|-------------------|
| Yes                               | 435 (25.01)       | 1.38 (1.10–1.72)              | 0.005               | -                    | -                 |
| No                                | 367 (23.01)       | 1                             | -                   | -                    | -                 |
| **High total cholesterol**        |                   |                               |                     |                      |                   |
| Yes                               | 192 (24.46)       | 1.08 (0.89–1.32)              | 0.43                | -                    | -                 |
| No                                | 367 (23.01)       | 1                             | -                   | -                    | -                 |
| **Low HDL cholesterol**           |                   |                               |                     |                      |                   |
| Yes                               | 306 (26.33)       | 1.36 (1.13–1.65)              | 0.001              | 1.20 (0.98–1.47)     | 0.08              |
| No                                | 253 (20.77)       | 1                             | -                   | 1                    | -                 |
| **High LDL cholesterol**          |                   |                               |                     |                      |                   |
| Yes                               | 269 (23.33)       | 0.99 (0.82–1.19)              | 0.89                | -                    | -                 |
| No                                | 289 (23.57)       | 1                             | -                   | -                    | -                 |
| **High serum triglyceride**       |                   |                               |                     |                      |                   |
| Yes                               | 189 (25.03)       | 1.13 (0.93–1.38)              | 0.22               | -                    | -                 |
| No                                | 370 (22.77)       | 1                             | -                   | -                    | -                 |
| **Smoking**                       |                   |                               |                     |                      |                   |
| Never                             | 242 (22.92)       | 1                             | -                   | -                    | -                 |
| Past                              | 205 (24.73)       | 1.10 (0.89–1.37)              | 0.36               | -                    | -                 |
| Current                           | 113 (22.78)       | 0.99 (0.77–1.28)              | 0.95               | -                    | -                 |
| **BMI**                           |                   |                               |                     |                      |                   |
| <18.5                             | 12 (25.53)        | 1                             | -                   | -                    | -                 |
| 18.5–24.9                         | 137 (19.66)       | 0.71 (0.36–1.41)              | 0.33               | -                    | -                 |
| 25-29.9                           | 214 (21.31)       | 0.79 (0.40–1.55)              | 0.49               | -                    | -                 |
| ≥ 30                              | 197 (31.12)       | 1.32 (0.67–2.59)              | 0.42               | -                    | -                 |
| **High Waist Circumference**      |                   |                               |                     |                      |                   |
| No                                | 174 (21.19)       | 1                             | -                   | -                    | -                 |
| Yes                               | 386 (24.74)       | 1.22 (1.00–1.50)              | 0.05               | -                    | -                 |

<sup>a</sup>: Prevalence Odds Ratio  
<sup>b</sup>: In the bivariate analysis  
<sup>c</sup>: In the multiple logistic regression  
<sup>d</sup>: Mean (Standard Deviation)
### Table 4

| Risk Factor               | Dependent No. (%) | Crude POR\(^a\) (95%CI) | P value\(^b\) | Adjusted POR (95%CI) | P value\(^c\) |
|---------------------------|-------------------|------------------------|--------------|----------------------|--------------|
| **Physical Activity**     |                   |                        |              |                      |              |
| No                        | 490 (26.64)       | 1                      | -            | 1                    | -            |
| Yes                       | 70 (12.92)        | 0.41 (0.31–0.54)       | < 0.001      | 0.46 (0.35–0.62)     | < 0.001      |
| **Daily intake of calories** | 1414.47 (533.52)  | .9992 (.99–.99)         | < 0.001      | .99 (.99–.99)        | 0.001        |

a: Prevalence Odds Ratio  

b: In the bivariate analysis  

c: In the multiple logistic regression  

d: Mean (Standard Deviation)

### Discussion

The goal of our study was to assess the association between cardio-metabolic and demographic risk factors with BADL and IADL in the elderly people. The study results showed that 56.7% and 23.5% of the participants were dependent on the IADL and BADL respectively. After adjusting for potential confounders, being older and female, having a lower education level, a history of diabetes mellitus and past smoking, and no physical activity were significantly associated with dependency in the IADL. Also, being older and female, having a lower education level, low HDL cholesterol level, no physical activity and low daily intake of calories were associated with dependency in the BADL.

In a study in Poland, Ćwirlej-Sozańska et al. reported the lower dependency in the IADL and BADL (35.75% and 17.13%, respectively) than our study (21). Also, the percentages of the disability in our study were much higher than those observed in the studies in Ireland (22) and Nepal (23), but lower than in Panama (24).

In a study in Netherlands, age was reported as one of the most important predictors of disability (6). In another study conducted in 6 middle and low-income countries, older age, were also identified as the important factor affecting disability (7). Our study results were in agreement with these results.

In most studies, being a woman has been mentioned as one of the predictors of disability due to several reasons including higher life expectancy, lower-income and physical weakness (5, 21). However, in a study in Panama, being male increased the odds of disability in IADL and BADL, with the possible causes...
being lower smoking for women and equal monthly income in both sexes (24). In our study, being female was a risk factor for dependency in both IADL and BADL.

Chronic illness increases the chance of developing disability (21). According to the study by Marengoni et al. in Sweden, almost none of those without chronic disease were dependent in BADL. The incidence of disability was lowest in people with CVD and highest in those with mental and cerebrovascular diseases (25). In a study, in diabetic patients, BMI along with cardio-metabolic risk factors (hypertension, history of CVD, impaired eGFR, TG and HDL cholesterol) explained 25–35% excess odds of disability. In that study, diabetes mellitus increased 2-fold the risk of disability (26). Given that diabetes is associated with neuropathy, retinopathy, and PAD, such a relationship is not unexpected. In the another study in Australia, disability was associated with smoking (OR: 1.81 (1.18–2.78)), obesity (OR: 2.95 (1.83–4.77)), and diabetes (OR: 1.96 (1.11–3.45)) (5). Our study results showed that diabetes mellitus and past smoking were associated with dependency in the IADL, and low HDL cholesterol level was associated with dependency in the BADL.

In a review study (27), a disagreement between prospective and experimental studies was shown in the effect of late-life physical activity on minimizing functional disability. Several well-conducted prospective studies show a beneficial effect of physical activity on minimizing disability, whereas the majority of experimental studies that have examined disability as an outcome do not show improvements in disability. Our study showed that no physical activity was a risk factor for dependency in both of IADL and BADL.

One of the limitations of our study is that the analysis is based only on data from cardio-metabolic risk factors, while much of the association between illness and disability is due to synergistic effects (28). The second limitation of the present study is due to the design of our study, which is a cross-sectional and cannot confirm the temporal priority of disability and the risk factors. For example, the association of the dependency in IADL and BADL with decreased physical activity may be justified by the fact that people with disabilities in one domain are more likely to have limitations for having physical activity. Another limitation of the study is that although the BEH study is a population-based cohort, it does not include people residing in care facilities. Therefore, the percentage of people with IADL and BADL disability may be higher than it observed in this study.

**Conclusion**

After adjusting for other potential cardio-metabolic and demographic confounders, being older and female, having a lower education level and no physical activity are the cardio-metabolic and demographic risk factors that increases the odds of being depended in both of the BADL and IADL in the elderly people. A history of diabetes mellitus and past smoking increases only the odds of being depended in the IADL, and low HDL cholesterol level and low daily intake of calories are the risk factors that increases just the odds of being depended in the BADL. In order to confirm the above results, other studies are proposed in
which other confounding factors are also controlled, and the temporal priority of risk factors on disability are clear.

**Abbreviations**

BEH
Bushehr Elderly Health
BADL
Basic Activities of Daily Living
IADL
Instrumental Activities of Daily Living
OR (95%CI)
Odds Ratio (95% Confidence Interval)
ICF
International Classification of Functioning, Disability, and Health
ADL
Activities of Daily Living
GBD
Global Burden of Disease
BMI
Body Mass Index
HRs
Hazard Ratios
CVD
Cardiovascular Diseases
MI
Myocardial Infarction
DALY
Disability Adjusted Life Years
YLL
Years of Life Lost
YLD
Years lived with disability
LDL
Low Density Lipoprotein
HDL
High Density Lipoprotein
DAG
Directed Acyclic Graph
GOF
Declarations

Ethics approval and consent to participate: The Bushehr Elderly Health (BEH) program protocol was approved by the ethics committee of Endocrinology and Metabolism Research Institute, affiliated to Tehran University of Medical Science (code of ethics: IR.TUMS.EMRI.REC.1394.0036) as well as the Research Ethics Committee of Bushehr University of Medical Sciences (code of ethics: B-91-14-2). A written informing consent was signed by all the participants before enrolment in the study. In the case of illiterate participants, each participant was accompanied by a literate person from their family who read the consent form to him / her and gave him / her necessary explanations in the local dialect. After making sure that he / she understood all aspects of the study, the informed consent was signed by the participant and his / her companion.

Consent for publication: Not applicable

Availability of data and materials: The data that support the findings of this study are available from principal investigator of Bushehr Elderly Health (BEH) program but restrictions apply to the availability of these data, which were used under license for the current study, and so are not publicly available.

Competing interests: The authors declare that they have no competing interests.

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Authors' contributions: All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by BL, IN, AO, RH, GS, SG, and FS. The first draft of the manuscript was written by KK, AA, NF and MS, and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.
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Figures

Figure 1

The receiver operating characteristic (ROC) curve reflecting discrimination power of the multiple logistic model of IADL. The AUC provides the probability that a randomly selected pair of subjects, one truly disable, and one truly able, will be correctly ordered by the model. By “correctly ordered”, we mean that the disable subject will have a higher fitted value (i.e., higher predicted probability of the disability) compared to the able subject.
Figure 2

The ROC curve reflecting discrimination power of the multiple logistic model of BADL