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Research Article

Higher Income Enhances the Association Between Depressive Symptoms and Cardiovascular Disease

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Received date: June 24, 2024; Accepted date: July 04, 2024; Published date: July 10, 2024

Citation: Alisha Jiwani, (2024), Higher Income Enhances the Association Between Depressive Symptoms and Cardiovascular Disease, *Psychology and Mental Health Care*, 8(5): **DOI**:10.31579/2637-8892/289

Abstract

This research investigated the relationship between cardiovascular disease (CVD) and depressive symptoms, as well as whether income and sibling count moderated this relationship. The database employed included adults between the ages of 40 and 91 (N = 674, Mean= 59) that completed a general survey as new immigrants. Participant data consisted of demographic information pertaining to participant age and participant sibling count, health information regarding CVD history and depressive symptoms, and income information. The study results show that South Asian Indian immigrants who endorsed a history of CVD were associated with reporting more depressive symptoms. As well, South Asian Indian immigrants with higher reported incomes had a stronger association between CVD history and depression symptoms. The number of siblings did not influence the association between depressive symptoms and a history of CVD. It is possible that high stress occupations, often associated with higher incomes, contribute to the onset of CVD and depressive symptoms.

Keywords: cardiovascular; depression; income; sibling; acculturation; south asian indian

1. Background

South Asian immigrants are the most prevalent ethnic population that is growing the most rapidly in the United States [10,14]. By 2055, South Asians are estimated to be the largest immigrant group in the United States, (38% of individuals who were born outside of the United States) [18]. South Asian immigrants are more vulnerable to experiencing depression [20], while also being more likely to develop CVD throughout the lifespan [17]. This population is also susceptible to poverty [4,8,23], a social determinant that limits access to healthcare and social support [4,6]. Larger family size is also linked to increased poverty [3,16].

The aim of this research is to identify the relationship between CVD and depression in the South Asian Indian immigrant population. Income and sibling count may influence the relationship between CVD and depression. Poverty has been associated with psychological difficulties [6]. Additionally, increased sibling count has been linked to an increased likelihood of cardiac problems [21] and an increased risk of developing psychopathology in adulthood [22].

2. Materials and Methods

Study Overview

The present study used data from 'The New Immigrant Survey' (NIS) database. The adult sample of the 2003 NIS is globally representative, cross-sectional in nature, and based on self-report data [24]. The survey was comprised of 8,573 immigrants who were older than 18 years of age. They had all newly obtained permanent residency status in the U.S. [24]. The NIS consisted of a sample of adults who were allowed to obtain legal permanent residence between May and November 2003 [24]. Approximately three months after receiving legal permanent residency status, adults were contacted for either telephone or face to face interviews, which were conducted in their preferred language [24].

Participants

Within the 2003 NIS archival database, inclusion criteria were those who were between the ages of 18 and 95 at the time of survey completion. Additionally, only participant data from Indian immigrants were included [9].

Procedure

The NIS is made available to the public by visiting opr.princeton.edu. The questionnaire included items pertaining to demographics, pre-immigration experiences, employment, health, healthcare and life insurance, daily activities, income, assets, social variables, and migration history [9]. Following access to the NIS database, the Statistical Package

for the Social Sciences (SPSS) was used for data analyses. (IRB No. 21-0315)

Measures

Demographic Questions

Sibling Count – Moderator Variable #1

Sibling count was assessed with the following NIS question:

1. How many brothers and sisters do you have in total?

This variable was continuous. 'Don't know' and 'Refused to answer' responses were excluded. Missing and/or erroneous values were also removed.

Health Questions

Cardiovascular Disease – Predictor Variable

The presence of CVD was assessed using the following question as illustrated in the NIS health questionnaire:

1. Has a doctor ever told you that you had a heart attack, coronary heart disease, angina, congestive heart failure, or other heart problems?
2. Has a doctor ever told you that you had high blood pressure or hypertension?
3. Has a doctor ever told you that you had a stroke?

These variables were dichotomized by excluding 'Refused to answer' and 'Don't know' responses. Missing and/or erroneous values were also removed.

Depressive Symptoms – Outcome Variable

The World Health Organization's Composite International Diagnostic Interview Short Form (CIDI-SF) was used to assess depression on the NIS health questionnaire [19]. The CIDI-SF was modified from the long form of the CIDI, with aims to vet mental health disorders as indicated by criteria outlined in the Diagnostic and Statistical Manual of Mental Health Disorders, fourth edition (DSM-IV) [19]. The CIDI-SF maintains 93% classification accuracy for the presence of major depression, and possesses good reliability and validity [19].

As outlined below, the questions on the CIDI-SF covered a wide range of symptoms that are typically present in a depressive experience and or episode [19].

1. During the past 12 months, was there ever a time when you felt sad, blue, or depressed for two weeks or more in a row?
2. During those two weeks, did you lose interest in most things?
3. Thinking about those same two weeks, did you ever feel more tired out or low in energy than is usual for you?
4. During those same two weeks, did you lose your appetite?
5. Did you have more trouble falling asleep than you usually do during those two weeks?
6. During that same two-week period did you have a lot more trouble concentrating than usual?
7. People sometimes feel down on themselves, and no good or worthless. During that two-week period, did you feel this way?
8. Did you think a lot about death – either your own, someone else's, or death in general – during those two weeks?

A depression scale was created based on the sum of the aforementioned depression items. 'Refused to answer' and 'Don't know' responses were excluded, as well as missing or erroneous values.

Income Questions

Gross Income – Moderator Variable #2

Gross income was assessed using the following question as illustrated in the NIS income questionnaire [9]:

1. What is your gross income?

Nomenclature	*Conceptual Definition*	*Measure/Operational Def.*	*Form of Data*	*Role*
CV	Cardiovascular Disease	Has a doctor ever told you that you had a heart attack, coronary heart disease, angina, congestive heart failure, or other heart problems?	Categorical Data: Yes-No	IV: Predictor
DP	Depressive Symptoms	Adapted items from the CIDI-SF (7 items)	Continuous (Higher value represents greater presence of depressive symptoms)	DV: Outcome
IN	Income	What is your gross income?	Continuous (Higher value represents larger income level)	Moderator
SC	Sibling Count	How many brothers and sisters do you have in total?	Continuous	Moderator
EL	English Language Proficiency	How well do you speak English? How well do you write English? How well do you read English?		Covariate
GE	Gender	Are you male or female?	Categorical Data: Yes-No	Covariate
ED	Education Level	What is your highest degree, diploma or certificate that you have received?	Continuous	Covariate

Table 1: Summary of Variables

Preliminary Considerations

To detect small effects (α = 0.02) in a hierarchical regression model with up to 7 predictors (CVD, poverty status, CVD versus income, CVD versus sibling count, English language proficiency, gender, and education level), a sample of N = 395 was required to yield sufficient power (0.80). The sample of 674 Indian immigrants available for analysis was more than adequate for analytic purposes.

Data analysis

To assess the hypothesis that a history of CVD was associated with depression (or depressive symptoms), the bivariate (unadjusted) association was examined with a t-test for independent samples. Overall number of depressive symptoms served as the outcome variable and two groups, varying in whether or not they have a history of CVD served as the predictor variable. Covariates were then added to what became an Analysis of Covariance, testing the same hypothesis, now with an adjusted model. Further, the second and third hypotheses concerned the moderating role of income and sibling count. Moderation analyses were conducted via PROCESS [7]. The regression-based approach to moderation analysis utilized hierarchical regression models where interaction terms ('predictor by moderator') were entered in a second step. Significant ('predictor by moderator') interaction effects served as evidence of moderation. Regarding the hypothesis on the moderating role of income, a significant interaction between CVD history and income was examined for its interactive effects on depressive symptoms at three levels of income. A similar analytic approach was used for the hypothesis concerning the moderating role of sibling count. In this case, three levels of sibling count were entered.

3. Results

The primary predictor in subsequent analysis (CVD history) and the outcome of interest (presence of depressive symptoms) assumed dichotomous form in the investigation. For this reason, they were not screened for standard distributional assumptions. Other variables, however, assumed a scaled, continuous form, including age, total number of siblings, and gross income. These were screened for both normality and outliers. The age distribution was effectively normal in shape, but both number of siblings and gross income were positively skewed, and screening identified 11 outliers at the high end of each scale (9 or more siblings; gross income >/= 213,000). To address the skewness in these distributions, a square root transformation was performed on each variable rendering them effectively normal, and yielding only a single outlier for each variable. These outliers were removed. Transformed versions of sibling count and gross income (which serve as moderators in analyses pertaining to hypotheses 2 and 3) were used in the analyses that followed.

	N Statistic	Min Statistic	Max Statistic	Mean Statistic	SD Statistic	Skewness Statistic	Skewness Std. Error	Kurtosis Statistic	Kurtosis Std. Error
Sib Total	653	0	18	2.73	2.04	1.67	0.09	5.50	0.19
Sqrt (Sib Count)	653	0.00	4.24	1.53	0.62	0.08	0.09	0.79	0.19
Gross Income	674	0.00	623000.00	51667.39	58387.81	2.29	0.09	14.09	0.18
Sqrt (Gross Income)	674	0.00	789.30	178.07	141.38	0.19	0.09	-0.78	0.18

Table 2: Descriptive Statistics

Basic demographic characteristics of the final sample available for analysis can be found in Table 3. The original sample of South Asian Indian immigrants to the USA included a total of 771 adults. The current sample was smaller than the original because some outlying cases were removed (e.g. those 92 or older). The sample was disproportionately male (58.6%) and older than a normative sample from the general population. For example, ages ranged from 40 – 91 (Mean = 59.40) and over one third of the sample was 60 or older. While almost one quarter reported no gross income (22.8%), a considerable number reported incomes higher than 100,000 (16.8%). Participants appeared to come from relatively large families insofar as virtually all had siblings (95.6%) and many reported coming from families with five or more siblings (17.9%). Overall, their health status, as disclosed to interviewer, was primarily good to excellent (95.1%).

	n	**%**
Gender		
Male	395	58.6
Female	279	41.4
Age (M = 59.40, SD = 11.07) Range: 40-91(included)		
40-49	122	18.1
50-59	315	46.7
60-69	122	18.1
70-79	66	9.8
80-89	45	6.7
90-99	4	0.6
100 or older		
Gross Income (M = 51,667.54, SD = 58,387.81)		
No income	154	22.8
1 – 35k	180	26.7

36 – 75k	132	19.6
76 – 100k	95	14.1
> 100k	113	16.8
Sibling Count (M = 2.73, SD = 2.04)		
0	29	4.4
1	179	27.4
2	167	25.6
3	102	15.6
4	59	9.0
5 or more	117	17.9
Health Status (M = 4.06, SD = 0.94)		
Poor	8	1.2
Fair	25	3.7
Good	156	23.1
Very good	214	31.8
Excellent	271	40.2

Table 3: Sample Characteristics (N = 674)

	n	**%**
Heart problem	9	1.3
High Blood Pressure	55	8.2
Heart Attack	2	0.2
Angina	1	0.1
Stroke	0	0.0
Any CVD	**59**	**8.8**

Table 4: Cardiovascular Disease

	n	**%**
Felt Sad	32	4.7
Lose Interest	9	1.3
More tired	10	1.5
Lose appetite	8	1.2
Trouble falling asleep	8	1.2
Trouble concentrating	9	1.3
Feel down on self	6	0.9
Think about death	3	0.4
Any Depressive Symptom	**32**	**4.7**

Table 5: Depressive Symptoms

Apart from the moderators in the proposed model (gross income, number of siblings), demographic characteristics including gender, age, and general health status were examined as possible covariates for subsequent analyses. No gender differences were found, and there was no significant association between age and the outcome of interest (depressive symptoms). There was, however, a small negative correlation between general health and depression ($r = -.155$, $p <$ .001) indicating that the more favorable one's health status the less likely they were to report depressive symptoms. General health status was thus included as a covariate in the regression models that follow.

Association between CVD & Depression

To test the hypothesis that a history of CVD and depressive symptoms in the sample would be associated, a series of chi-square analyses were conducted. There was some evidence supporting the hypothesis, but it appeared to be restricted to one of the eight symptoms of depression (felt sad/depressed). Nevertheless, those with a history of CVD were significantly more likely to report at least one depressive symptom (11.9%) than those with no history of CVD (4.1%). As indicated by the Odds ratio of 3.18, this suggests that those with a history of CVD were more than three times as likely to report a depressive symptom than those with no CVD history.

	Any CVD				
Depressive Symptoms	***No (n = 615)***	***Yes (n = 59)***	***χ^2 (1)***	***Sig***	***Odds Ratio (CI)***
Felt sad/depressed*	25 (4.1)	7 (11.9)	7.24	.007	3.18 (1.31, 7.70)
Lose Interest	9 (1.5)	0 (0.0)	0.88	.350	NA
Felt more tired	9 (1.5)	1 (1.7)	0.02	.888	1.16 (.15, 9.33)
Lose appetite	7 (1.1)	1 (1.7)	0.14	.706	1.50 (.18, 12.38)
Trouble falling asleep	7 (1.1)	1 (1.7)	0.14	.706	1.50 (.18, 12.38)
Trouble concentrating	8 (1.3)	1 (1.7)	0.06	.801	1.31 (.16, 10.64)
Feel down on self	6 (1.0)	0 (0.0)	0.58	.446	NA
Think about death	3 (0.5)	0 (0.0)	0.29	.591	NA
Any depressive symptom*	25 (4.1)	7 (11.9)	7.24	.007	3.18 (1.31, 7.70)

Table 6: The Association between CVD and Depressive Symptoms

In an adjusted logistic regression model, however, CVD did not contribute significantly to the model beyond what could be explained by the general health status covariate χ^2 (1) = .970, p = .325. Health status was significantly associated with the presence of depressive symptoms in this model Wald (1) = 10.15, p = .001, OR = .551 (.38, .80), indicating that the better a respondent's health, the less likely they were to report depressive symptoms.

Nevertheless, a history of CVD was itself associated with health status (β = -.305, p < .001), suggesting that the effects of CVD on depressive symptoms might be indirect. To examine this possibility a mediation model was tested with history of CVD serving as the predictor, health status as the mediator, and the presence of depressive symptoms as the outcome.

The link between CVD and health status was significant, and health status had a significant direct effect on the likelihood of depressive symptoms. The indirect effect of CVD on depressive symptoms was significant B = 0.604 (.14, 1.15) as indicated by a bias-corrected bootstrapped confidence interval excluding zero effect. The finding suggests that a history of CVD in this sample might make one vulnerable to depressive symptoms that undermine their health status.

Income Moderates the Effects of CVD & Depression

The moderating effects of income on the association between CVD and depressive symptoms was examined with a logistic regression-based approach to moderation analysis using the PROCESS software [7]. In a hierarchical model, the predictor (CVD) and the proposed moderator (income), along with the covariate (health status), entered in a first step, and the interaction between them (CVD versus. Income) entered in a second step. Evidence of moderation takes the form of a significant interaction effect that is then probed with simple slopes analysis.

The (CVD versus Income) interaction effect was significant χ^2 (1) = 4.02, p = .045 indicating that the effects of CVD on depressive symptoms was different for those with different income levels. More specifically, analysis of the conditional effects of CVD on depressive symptoms at low (-1 SD), mean, and high (+1 SD) income levels indicated that the effect of interest was restricted to those with relatively high income in this adjusted model (i.e. controlled for overall health status).

	Co-efficient	**SE**	**Z**	**p**	**LLCI**	**ULCI**
Constant	-.4152	.7343	-.5655	.5718	-1.8544	1.0240
CVD	.6315	.4893	1.2907	.1968	-.3274	1.5905
Gross Income	-.0002	.0015	-.1315	.8954	-.0031	.0027
CVD x Income	.0074	.0037	1.9817	.0475	.0001	.0147
Health Status	-.7072	.1950	-3.6259	.0003	-1.0894	-.3249

Table 7: Gross Income Moderates the Association Between CVD and Depressive Symptoms

The three lines in Figure 1 represent the association between CVD and depressive symptoms at three levels of the moderator (low income, mean income, high income). The blue line at the top represents the significant (positive) association between CVD and depressive symptoms for those with relatively high income. The middle red line represents the non-significant, small positive association among those with mean level income. The bottom gray line represents the slight, non-significant negative association for those with relatively low income.

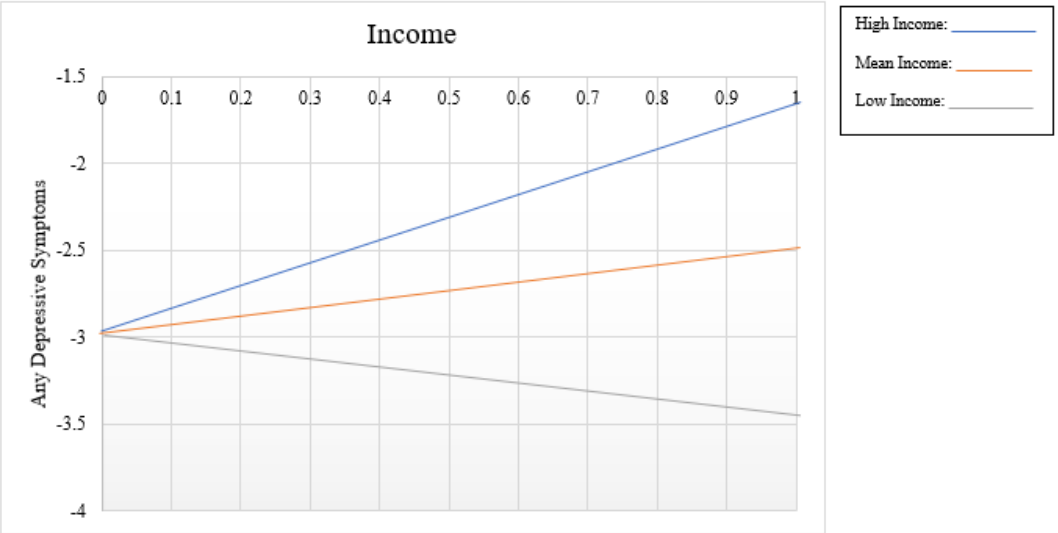

Figure 1: Income Moderation Effect

The moderating effects of sibling count on the association between CVD and depressive symptoms was examined with a logistic regression-based approach to moderation analysis using the PROCESS software [7]. In a hierarchical model, the predictor (CVD) and the proposed moderator (sibling count), along with the covariate (health status) were entered in a first step, and the interaction between them (CVD versus. Sibling Count) was entered in a second step. There was no evidence of moderation.

The (CVD versus. Sibling Count) interaction effect was not significant χ^2 (1) = 0.244, p = .8760, indicating that the effects of CVD on depressive symptoms was not different for those with different numbers of siblings. More specifically, analysis of the conditional effects of CVD on depressive symptoms at low (-1 SD), mean, and high (+1 SD) sibling count indicated that an effect of interest was not present across degrees of sibling count in this adjusted model (i.e. controlled for overall health status). The absence of moderation is depicted in Figure 2. Precisely, the effects (CVD > dep symptoms) are essentially the same at the three levels of sibling count (low, mean, high).

	Co-efficient	SE	Z	p	LLCI	ULCI
Constant	-.3955	.7317	-.5405	.5889	-1.8296	1.0386
CVD	.3053	.5385	.5669	.5708	-.7502	1.3608
Sqrt Sib	-.0446	.3256	-.1368	.8912	-.6827	.5936
Interaction 1	-.1221	.7800	-.1565	.8756	-1.6509	1.4067
Health Status	-.7038	.1940	-3.6272	.0003	-1.0840	-.3235

Table 8: Sibling Count Does Not Moderate the Association Between CVD and Depressive Symptoms

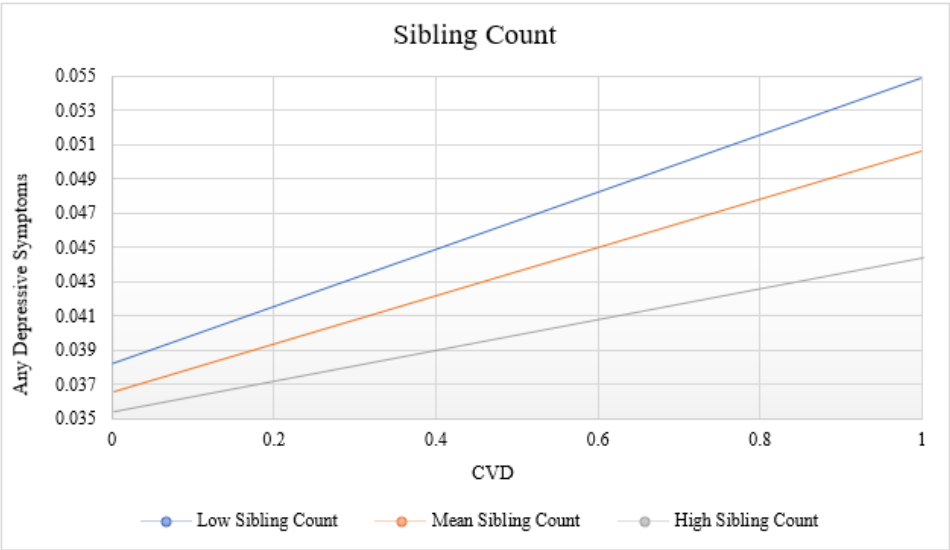

Figure 2: Absence of Sibling Count Moderation

4. Discussion

This study first aimed to evaluate the association between CVD history and depressive symptoms among South Asian Indian immigrants. The first research hypothesis predicted that there would be a positive correlation between CVD history and depressive symptoms. This hypothesis was supported. South Asian Indian immigrants who endorsed a history of CVD experienced more depressive symptoms. This is consistent with earlier research [11,17]. The second research hypothesis predicted that the association between CVD history and depressive symptoms would be moderated by income, in that the association between depressive symptoms and a history of CVD would be more pronounced for those with a lower income. This hypothesis was not supported. It is possible that participants in this study with lower incomes did not have the means to purchase cigarettes, alcohol, or excess amounts of food to develop risk factors for CVD. On the contrary, South Asian Indian immigrants with higher reported incomes had a stronger association between CVD history and depressive symptoms. It is possible that the participants in this study with high incomes had high stress occupations, which contributed to the onset of CVD and depressive symptoms. This may have occurred by metabolic and/or behavioral pathways. However, this is an unexpected finding given that previous research had identified low income as a risk factor [2,6]. Lastly, the final hypothesis predicted that the association between CVD history and depressive symptoms would be more pronounced for those with more siblings. This hypothesis was not supported as there was no evidence of moderation. Hence, the number of siblings did not influence the association between depressive symptoms and a history of CVD.

It is important to note that the rates of depressive symptoms and CVD histories endorsed are remarkably low relative to prevalence rates in India and the United States. To further illustrate, 48.6% of Americans had some facet of CVD [15]. Regarding past 12-month depression, prevalence among Americans in 2020 was 1 in 10 adults (10%) and 1 in 5 adolescents (20%) [5]. In 2022, the prevalence rate of CVD in India was 29% for 45 years of age and older [13]. In terms of the prevalence of depression in India, approximately 33% of patients seeking medical care may have depressive symptoms [1]. The prevalence of major depressive disorder/depressive episode is estimated to range from 3.2%-4.7% [1]. When comparing these statistics to the rates endorsed in the current study, it is possible that lower reported rates of depressive symptoms (4.7%) and CVD history (8.8%) may be attempts to withhold information. The participants may have feared that disclosing mental and physical health issues would potentially jeopardize their residency/visa status, as well as access to immigration benefits. From a cultural lens, it is common for South Asian Indians to underreport symptoms given that their cultural milieu tends to discourage the expression of vulnerability [12].

Furthermore, the low prevalence rates of CVD and depressive symptoms in this sample may relate to self-selection bias. Specifically, immigrating to the U.S. could increase access to greater resources and higher levels of education as opposed to what is available to those remaining in India. Low reported occurrences of CVD and depressive symptoms in this study may also relate to improved living conditions and greater income opportunities for those immigrating to the U.S. relative to those who remain in India. Taken together, access to more opportunities and resources may enhance one's quality of life, thereby reducing the rates of depressive symptoms and CVD.

5. Limitations

As previously mentioned, the low rates of depressive symptoms and CVD histories make it difficult to statistically detect differences and effects. In essence, these low rates compromise the power available for the analysis. The second limitation of this study is that it utilized an archival database. Hence, there was no way to oversee the data collection process or control for the quality of data that was obtained. A third limitation of this research is that self-report data were provided for all of the variables used in this study. Self-report data may not accurately reflect actual prevalence rates and experiences given that culturally, South Asian Indians are less inclined to report medical and mental health symptoms or conditions. Positive impression management and social desirability effects may influence what the participants disclosed at the time. As previously noted, attaining certain immigration benefits and ensuring the permanence of one's residency status may have influenced what they chose to share or not share about themselves. Another limitation of this study is that the sample was confined to immigrants who had resided in the United States for at least one year, at which time they received legal permanent residency status. Therefore, other long-term immigrants, as well as undocumented immigrants, would have been excluded, leaving these populations disproportionately represented in the data that were analyzed.

6. Conclusions

This study provides additional support for the longstanding relationship between CVD and depressive symptoms, and also holds true for South Asian Indian immigrants. It also calls attention to the role of high-income level in the relationship between CVD and depressive symptoms in this population. Future research on noncommunicable diseases among South Asian Indian immigrants should be conducted to decrease the burdens of healthcare costs, inform the medical and psychological communities that work with these individuals, and improve the well-being of South Asian Indian immigrants new to the United States.

Future research should further investigate the unexpected finding of this study; higher income appears to yield a more pronounced relationship between CVD history and depressive symptoms in South Asian Indian Immigrants residing in the United States. Investigating these questions, to a greater extent, may expand the existing knowledge base as it relates to the variables that influence the physical and mental health of South Asian Indian immigrants. Perhaps the underlying mechanisms that contribute to the relationship between CVD and depressive symptoms differ across income, whereby collective pathophysiological factors are more responsible among individuals with higher incomes than behavioral pathways. These are essential questions to address in future research. Collecting data from various sources in future research may enhance reliability and validity, therefore increasing the power and generalizability of the research. These findings may be useful in developing preventative measures for individuals in this demographic to safeguard against the co-occurrence of CVD and depressive symptoms.

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DOI:10.31579/2637-8892/289