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The Interactive Effects of Chronic Health Conditions and Depression on Life Satisfaction

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Abstract

This study explores how the presence of a depressive disorder amplifies the negative impact of chronic physical illnesses on life satisfaction when the two co-occur, compared with the effects of each chronic condition alone. This study employs multivariate logistic regression to examine these associations using data from the 2022 Behavioral Risk Factor Surveillance System (BRFSS), a large-scale national health survey. The analysis revealed that individuals with both a physical and a mental health condition had significantly lower odds of reporting life satisfaction compared with those with only a single physical condition. In particular, arthritis, one of the most prevalent chronic health conditions among adults in the United States, emerged as especially significant. Respondents with arthritis were less likely to report life satisfaction than those without the condition or those with other chronic health conditions. This negative impact was further intensified when arthritis co-occurred with depressive disorder. The odds ratio for arthritis alone was 0.847, already relatively low among the chronic health conditions analyzed. However, when combined with depressive disorder, it dropped sharply to 0.449. This substantial decline highlighted how the coexistence of a mental health disorder can significantly amplify the adverse effects of arthritis on life satisfaction. A similar pattern was observed for asthma, where the odds ratio decreased from 0.877 (asthma alone) to 0.633 when combined with depressive disorder. These findings demonstrate the critical importance of integrating mental health care into the management of chronic physical illnesses, as the interaction between the two can substantially diminish individuals' life satisfaction.

Key Words: Life Satisfaction, Chronic Health Conditions, Mental Disorder, Interactive Effects, BRFSS.

1. Introduction

Individuals strive to maximize their overall happiness throughout their lives, given their unique life circumstances, such as cultural expectations, social roles, and the transitions of the life course (Doh and Chung, 2020). The overall happiness is commonly referred to as life satisfaction, which reflects how individuals perceive and evaluate the quality of their lives, as well as the degree of fulfillment and enjoyment they experience (Margolis et al., 2019; Willroth et al., 2020; Speed and Lamont, 2023). In recent years, improvements in healthcare and living standards have enabled individuals to live longer than ever before. This increase in longevity might suggest that they are enjoying longer lives. However, this extended lifespan may not always correspond with a better quality of life, as many individuals now spend a considerable portion of their later years in poor health. As a result, enhancing the overall life satisfaction, particularly for adults, has become an increasingly important social issue. Life satisfaction has been shown, especially, to have a strong association with positive health outcomes, including multiple indicators of good physical and mental health (Proctor et al., 2018; Margolis et al., 2019). On the other hand, studies have consistently demonstrated that both physical health problems and mental health symptoms are associated with significantly poorer quality of life over time (Brettschneider et al., 2013; Butler et al., 2018; O'Loughlin et al., 2022).

Chronic health conditions are typically defined as diseases that persist for a year or more and involve ongoing medical care, limitations in daily activities, or both (Froehlich-Grobe et al., 2016; Prazeres and Santiago, 2016; Larsen et al., 2017). Additionally, studies (Buttorff et al., 2017; Boersma et al., 2020) have reported that individuals with chronic health conditions often require a more extensive range of healthcare services and additional support from family caregivers. Ultimately, chronic health conditions lead to a decline in overall quality of life and a decrease in life satisfaction. These adverse effects are even more pronounced when individuals experience

multimorbidity, the coexistence of two or more chronic conditions. In such cases, life satisfaction tends to decline significantly. This issue is emerging as a significant public health concern, particularly because individuals with a chronic illness are at a higher risk of developing additional conditions, further compounding the burden on their overall life satisfaction (Fortin et al., 2007; Hunger et al., 2011). As the population ages, the prevalence of multimorbidity is expected to continue rising in the United States. To address this challenge, it is essential to deepen our understanding of the collective impact of multiple chronic conditions on life satisfaction, moving beyond analyses that focus solely on individual diseases. Ideally, research should explore all possible combinations of chronic health conditions to capture their intricate, interactive effects on life satisfaction. However, analyzing the impact of these combinations remains a significant methodological challenge due to their complexity (Fortin et al., 2007).

As an alternative, grouping chronic health conditions with mental illness may provide a more practical and informative approach to understanding their impact on life satisfaction (Newman et al., 2017). However, limited research has explored the interaction effects between physical and mental health conditions on life satisfaction. Specifically, few studies have examined whether the negative impact of chronic physical illnesses intensifies when they co-occur with a mental disorder. As such, there is a need for research that explores the interactive effects of co-occurring chronic physical health conditions and mental illness, referred to as physical-mental multimorbidity, on life satisfaction (Romano et al., 2021). This study aims to fill the gap by investigating how the presence of a depressive disorder amplifies the negative impact of chronic physical illnesses on life satisfaction when they co-occur, compared with the effects of each chronic condition alone. The findings are expected to enhance understanding of how life satisfaction is affected not only by individual chronic health conditions but also by the co-occurrence of physical and mental health conditions, providing deeper insight into how depressive disorder may exacerbate the decline in life satisfaction associated with chronic physical illnesses. As a result of these findings, healthcare strategies and programs can be more effectively tailored to individual needs and become more comprehensive by addressing both physical and mental health jointly rather than separately. Multivariate logistic regression was employed to assess the interactive effects of physical and mental health conditions on life satisfaction among U.S. adults aged 18 years and older. This analysis utilized data from the 2022 Behavioral Risk Factor Surveillance System (BRFSS), as detailed in section 3.

2. Analytical Framework

This study investigates the interactive effects of co-occurring chronic physical health conditions and depressive disorder on adults' perceived life satisfaction. Life satisfaction is measured as a self-reported, dichotomous dependent variable. Respondents were coded as '1' if they reported being 'very satisfied' or 'satisfied' with their lives and as '0' if they reported being 'dissatisfied' or 'very dissatisfied,' as detailed in section 3. The likelihood of reporting life satisfaction can be estimated using a linear probability model, in which the binary outcome is regressed on a set of explanatory variables, including the presence of chronic health conditions.

$$y_i = \beta_0 + x_{ik}\beta_k + u_i \quad (1)$$

where the subscript i denoted an observation, and y_i was the probability of reporting 'very satisfied' or 'satisfied' with her/his life at the i^{th} observation. x_{ik} was an i x k matrix of explanatory variables where k was the number of explanatory variables. β_0 was a constant term, and β_k was a coefficient matrix of the equation with a dimension of k x 1. u_i was the error term at each observation i, with the expected value of u_i, $E(u_i) = 0$. Thus, the conditional expected value of the dependent variable was expressed as $E(y_i|x_{ik}) = \beta_0 + x_{ik}\beta_k$. The predicted values of the dependent variables should have a probability of occurrence that falls between zero and one. However, the linear probability model has a limitation known as the unboundedness problem, which can result in predicted values falling outside of the meaningful range of zero to one. Consequently, the predicted probabilities can differ significantly from the observed values for each observation. To address this issue of unboundedness, the binomial logit model has been widely adopted in research involving binary dependent variables (Maddala, 1992; Kleinbaum and Klein, 2002; Lee et al., 2023; James et al., 2024).

In the logistic regression, an unknown probability (y) could be estimated for any given linear combination of independent variables. The dependent variable in the logistic regression follows the Bernoulli distribution (Marshall and Olkin, 1985), which is a specific case of the binomial distribution with a single trial: here, a success is represented by '1' and a failure by '0'. If the probability of success is y, the probability of failure would then be ($1 - y$). In the study by Son (2022), the odds ratio from logistic regression was calculated as the exponentiated values of the estimated coefficient ($\hat{\beta}_k$) for each independent variable, as outlined in the standard algebraic procedures.

$$\text{logit}(y) = \beta_0 + x_{ik}\beta_k \quad (2)$$

where y is the probability of reporting 'very satisfied' or 'satisfied.' β_0 is the intercept coefficient, and β_k is the regression coefficient for each independent variable (x_1, x_2, …x_k). The present study derives odds ratios for reporting life satisfaction from multivariate logistic regression analysis to assess the impact of individual chronic conditions, a composite chronic health condition score, and the combination of chronic health conditions with depressive disorder on life satisfaction, which served as the dependent variable. All models control for a range of socio-demographic variables, including marital status, employment status, age group, income level, race, educational attainment, body mass index (BMI), and physical activity.

3. Data and Empirical Implementation

The data used in this analysis were obtained from the 2022 Behavioral Risk Factor Surveillance System (BRFSS), a collaborative project involving all U.S. states and the Centers for Disease Control and Prevention (CDC). The BRFSS is an ongoing health-related telephone survey that collects data through interviews conducted via landline and cellular telephone. It focuses on health-related risk behaviors, chronic health conditions, access to health care, and the use of preventive services related to the leading causes of death and disability among noninstitutionalized adults aged 18 or older residing in the United States. The operations of the BRFSS are managed by state health departments, which conduct the interviews either directly or through contracted agencies. These state health departments use BRFSS data for various purposes, including identifying demographic variations in health-related behaviors, implementing and evaluating public health programs, addressing emerging health issues, proposing legislation for health initiatives, and measuring progress toward state health objectives.

This study analyzed data on U.S. adults aged 18 or older collected from 30 states and Washington, D.C. (Centers for Disease Control and Prevention, 2022). Observations with 'missing values,' 'unanswered questions,' 'don't know/not sure,' 'questions not asked,' or 'refusals' were excluded from the analysis. Out of a total of 445,132 survey participants, 181,781 (40.84%) completed all questions related to life satisfaction, socio-demographic variables, and chronic health conditions. The remaining observations were further examined by male and female subgroups to assess the impact of chronic health conditions on self-reported life satisfaction. Table 1 presents definitions of life satisfaction and the socio-demographic variables used in this study, and Table 2 shows the summaries of their characteristics.

Table-1 Definitions of variables

Variable	Definition
Life satisfaction	Dichotomous variable that equals 1 if a respondent with her/his life is very satisfied or satisfied
Married	A respondent is married or a member of an unmarried couple.
Employed	A respondent is employed for wages or self-employed.
Age group	
Age1834	Dichotomous variable that equals 1 if 18 ≤ respondent's age ≤ 34.
Age3549	Dichotomous variable that equals 1 if 35 ≤ respondent's age ≤ 49.
Age5064	Dichotomous variable that equals 1 if 50 ≤ respondent's age ≤ 64.
Age65+	Dichotomous variable that equals 1 if respondent's age ≥ 65.
Income	
Income 25	A respondent's annual household income from all sources < $25,000.
Income 25-50	$25,000 ≤ a respondent's annual household income from all sources < $50,000.
Income 50-100	$50,000 ≤ a respondent's annual household income from all sources < $100,000.
Income 100+	A respondent's annual household income from all sources ≥ $100,000.
Races	
White, non-Hispanic	A respondent is white only, non-Hispanic.
Black, non-Hispanic	A respondent is black only, non-Hispanic.
Hispanic	A respondent is Hispanic.
Others, non-Hispanic	A respondent is an Asian, American Indian/Alaskan Native, or other race, non-Hispanic.
Education	
Less high school	A respondent did not graduate high school
High school graduate	A respondent completed grade 12 or General Educational Development.
Some college	A respondent completed college 1 year to 3 years (some college or technical school).

College graduate	A respondent completed college 4 years or more.
BMI	
Underweight	Dichotomous variable that equals 1 if a respondent is underweight (BMI[a] < 18.50).
Normal weight	Dichotomous variable that equals 1 if a respondent is normal weight (18.50 ≤ BMI[a] < 25.00).
Overweight	Dichotomous variable that equals 1 if a respondent is normal weight (25.00 ≤ BMI[a] < 30.00).
Obese	Dichotomous variable that equals 1 if a respondent is obese (30.00 ≤ BMI[a]).
Exercise	Dichotomous variable that equals 1 if respondent participates in any physical activities or exercises such as running, calisthenics, golf, gardening, or walking for exercise during the past month.

Source: 2022 Behavioral Risk Factor Surveillance System (BRFSS) at https://www.cdc.gov/brfss/.
Notes: a. Body Mass Index (BMI): weight (kg) divided by square of height (meter).

3.1. Life Satisfaction

Studies (Loewe et al., 2014; Proctor et al., 2018; Margolis et al., 2019) have found that a high level of life satisfaction is strongly associated with several aspects of overall health and happiness. These studies also highlight life satisfaction as one of the most reliable indicators of well-being and positive functioning. With the aging population in the United States, enhancing life satisfaction among adults has become an increasingly important social issue. Each year, the BRFSS coordinators collaborate with the CDC to determine the content of the survey questionnaire, which consists of a core component, optional modules, and state-added questions. In 2022, a module focusing on life satisfaction was optional. States could choose to add the life satisfaction module to their surveys. A total of 30 states and the District of Columbia opted to include this module (Centers for Disease Control and Prevention, 2022). Survey participants were asked, "In general, how satisfied are you with your life?" Response options consisted of 'very satisfied,' 'satisfied,' 'dissatisfied,' and 'very dissatisfied.' Participants who responded 'very satisfied' or 'satisfied' were categorized as having life satisfaction. Notably, 94.4% of survey participants reported being satisfied with their lives.

Table-2. Sociodemographic characteristics

	Overall	Male	Female
Observations	181,781 (100%)	89,728 (49%)	92,053 (51%)
Life satisfaction	0.944 (0.231)	0.944 (0.230)	0.943 (0.232)
Married	0.587 (0.492)	0.614 (0.487)	0.559 (0.497)
Employed	0.610 (0.488)	0.664 (0.473)	0.555 (0.497)
Age group			
Age1834	0.253 (0.435)	0.260 (0.439)	0.245 (0.430)
Age3549	0.253 (0.435)	0.253 (0.435)	0.254 (0.435)
Age5064	0.265 (0.441)	0.264 (0.441)	0.267 (0.442)
Age65+	0.229 (0.420)	0.224 (0.417)	0.234 (0.423)
Income			
Income 25	0.153 (0.360)	0.125 (0.331)	0.180 (0.385)
Income 25-50	0.246 (0.431)	0.230 (0.421)	0.263 (0.440)
Income 50-100	0.296 (0.456)	0.308 (0.462)	0.284 (0.451)
Income 100+	0.305 (0.461)	0.338 (0.473)	0.273 (0.445)
Races			
White, non-Hispanic	0.612 (0.487)	0.617 (0.486)	0.607 (0.488)
Black, non-Hispanic	0.107 (0.309)	0.098 (0.298)	0.116 (0.320)
Hispanic	0.180 (0.385)	0.184 (0.387)	0.177 (0.382)
Others, non-Hispanic	0.100 (0.301)	0.101 (0.301)	0.100 (0.300)
Education			
Less high school	0.095 (0.293)	0.100 (0.300)	0.090 (0.286)
High school graduate	0.260 (0.439)	0.279 (0.449)	0.240 (0.427)
Some college	0.323 (0.468)	0.309 (0.462)	0.337 (0.473)
College graduate	0.323 (0.468)	0.312 (0.463)	0.334 (0.472)
BMI			
Underweight	0.016 (0.125)	0.013 (0.115)	0.018 (0.134)
Normal weight	0.284 (0.451)	0.247 (0.431)	0.320 (0.467)
Overweight	0.348 (0.476)	0.396 (0.489)	0.298 (0.458)
Obese	0.353 (0.478)	0.343 (0.475)	0.363 (0.481)
Exercise	0.779 (0.415)	0.802 (0.399)	0.755 (0.430)

Source: 2022 Behavioral Risk Factor Surveillance System (BRFSS) at https://www.cdc.gov/brfss/.
Notes: Standard deviations are in parentheses. Means (%) and standard deviations are weighted by the BRFSS sample weight factor. All means are statistically significant using two tailed t-test with 95% confidence interval.

3.2. Sociodemographic Variables

The empirical models incorporated socio-demographic variables, including marital status, employment status, age group, income level, race, education level, Body Mass Index (BMI), and exercise. These variables are widely used in research examining life satisfaction and health-related quality of life (Luo et al., 2015; Argan and Mersin, 2021; Romano et al., 2021; Lee et al., 2023; Shah et al., 2023).

Studies by Kamp Dush et al. (2008), Botha and Booysen (2013), and Son (2020) have shown that an individual's level of happiness is closely linked to several family and marriage-related factors, such as the presence of children in the household, household income, traditional marital attitudes, the quality of marriage, and the interdependence of family networks. These studies specifically explored the relationship between marital status and life satisfaction, consistently finding that married individuals report significantly higher levels of life satisfaction compared with those who do not fall within the married category. In the BRFSS survey, participants reported their marital status by selecting from six categorical options: married, divorced, widowed, separated, never married, and a member of an unmarried couple. For analysis, those identifying as either married or a member of an unmarried couple were classified as married. 58.7% of all participants, 61.4% of males, and 55.9% of females reported being married.

The study by Binder and Coad (2013) reported that employment and life satisfaction are closely linked, identifying job satisfaction as a key component of overall life satisfaction. The findings highlighted that employed individuals were generally happier and more satisfied with their lives. In the BRFSS questionnaire, current employment status was recorded in eight mutually exclusive categories: employed for wages, self-employed, out of work for more than 1 year, out of work for less than 1 year, a homemaker, a student, retired, and unable to work. For the purposes of this study, respondents who reported being either 'employed for wages' or 'self-employed' were categorized as employed. Overall, 61.0% of respondents were employed, with 66.4% of male respondents and 55.5% of female respondents.

Several studies (Baird et al., 2010; Hunger et al., 2011; Sørensen, 2014) have identified a non-linear relationship between age and life satisfaction. These findings show that individuals tend to report the highest level of happiness in early adulthood and later life, with a noticeable decline during midlife. This pattern supports the view that life satisfaction follows a U-shaped trajectory across the life course. Additional research (Prazeres and Santiago, 2016; Larsen et al., 2017; Son, 2018; Argan and Mersin, 2021) has reached similar conclusions, employing age-group analyses in their empirical models of life satisfaction. In the present study, participants were categorized into four age groups: 18-34, 35-49, 50-64, and 65+. The distribution across age groups was relatively balanced, with the 50-64 age group comprising the largest proportion of participants (26.5%) and the 65+ age group the smallest (22.9%).

In economics, consumers are typically assumed to maximize their total utility – the overall satisfaction or benefits derived from consuming combinations of goods and services – within their budget constraints. As income rises, consumers gain greater purchasing power, allowing them to afford more or better combinations of goods and services. This leads to higher levels of total utility, assuming that the goods consumed provide positive marginal utility. This theoretical framework aligns with empirical research, which has found a positive relationship between income and life satisfaction (Wu, 2021; Aliyev et al., 2022). In the BRFSS, participants were asked about their annual household income from all sources, which ranged from less than $10,000 to $200,000 or more. This study reclassified income levels into four groups: less than $25,000, $25,000 to less than $50,000, $50,000 to less than $100,000, and $100,000 or more. In this income category, 15.3% of respondents reported their annual household income as less than $25,000, 24.6% reported their income between $25,000 and less than $50,000, 29.6% reported their income from $50,000 to less than $100,000, and 30.5% stated their annual household income was $100,000 or more.

Racial disparities in life satisfaction may arise from differences in socioeconomic status and individual circumstances, such as income, education level, social support, neighborhood quality, and personal experiences (Castañeda-Avila et al., 2024; Mbam et al., 2024). Research consistently shows that White individuals tend to report higher levels of life satisfaction compared with Black and Hispanic individuals. In this study, respondents' race was identified using two questions from the BRFSS: "Which one of these groups would you say best represents your race? (with seven response choices)" and "Are you Hispanic or Latino? (yes/no)." The BRFSS provided a section of 'calculated race variables' that categorized respondents into five groups, which this study collapsed into four: White, non-Hispanic; Black, non-Hispanic; Hispanic; and others (including multi-racial or other non-Hispanic respondents).

Education is closely linked to various social and economic factors that influence life satisfaction. Prior research (Powdthavee et al., 2015; Wu, 2021) has demonstrated that the indirect effects of education on life satisfaction are

positive, substantial, and statistically significant. Higher levels of education are associated with improved employment prospects, higher earnings, and more robust social networks, all of which contribute to enhanced overall life satisfaction. In this study, respondents were grouped into four categories based on their level of educational attainment: those who did not complete high school, high school graduates, respondents who attended some college or technical school, and those who graduated with a four-year college degree or higher.

Table-3. List of Chronicle Health Conditions in BRFSS Questionnaire

Chronic health conditions	**BRFSS questions**
Cardiovascular diseases	
Heart attack	(Ever told) you had a heart attack, also called a myocardial infarction?
Coronary Heart Disease	(Ever told) you had angina or coronary heart disease?
Stroke	(Ever told) you had a stroke?
Asthma	(Ever told) you had asthma?
Skin cancer	(Ever told) you had skin cancer that is not melanoma?
Other types of cancer	(Ever told) you had melanoma or any other types of cancer?
COPD	(Ever told) you had C.O.P.D. (chronic obstructive pulmonary disease), emphysema or chronic bronchitis?
Kidney disorder	Not include kidney stones, bladder infection or incontinence, were you ever told you had kidney disease?
Arthritis	(Ever told) you had some form of arthritis, rheumatoid arthritis, gout, lupus, or fibromyalgia? (Arthritis diagnoses include: rheumatism, polymyalgia rheumatica; osteoarthritis (not osteporosis); tendonitis, bursitis, bunion, tennis elbow; carpal tunnel syndrome, tarsal tunnel syndrome; joint infection, etc.)
Diabetes	(Ever told) you have diabetes? This excludes pre-diabetes, borderline diabetes, gestational diabetes (or diabetes during pregnancy).
Depressive disorder	(Ever told) you had a depressive disorder (including depression, major depression, dysthymia, or minor depression)?

Source: 2022 Behavioral Risk Factor Surveillance System (BRFSS) at https://www.cdc.gov/brfss/.

Table-4. Prevalence of chronic health conditions, chronic health condition scores, and physical-mental multimorbidity

	Overall	**Male**	**Female**
Individual chronic health condition			
Cardiovascular diseases	0.092 (0.289)	0.104 (0.306)	0.079 (0.269)
Asthma	0.151 (0.358)	0.122 (0.328)	0.180 (0.384)
Skin cancer	0.059 (0.236)	0.058 (0.234)	0.061 (0.239)
Other types of cancer	0.085 (0.279)	0.078 (0.267)	0.092 (0.290)
COPD	0.066 (0.249)	0.059 (0.235)	0.740 (0.262)
Kidney disorder	0.037 (0.189)	0.034 (0.180)	0.040 (0.197)
Arthritis	0.276 (0.447)	0.243 (0.429)	0.310 (0.463)
Diabetes	0.124 (0.329)	0.133 (0.339)	0.115 (0.318)
Depressive disorder	0.213 (0.410)	0.151 (0.358)	0.277 (0.447)
Number of chronic health conditions			
0	0.418 (0.493)	0.461 (0.499)	0.373 (0.484)
1	0.288 (0.453)	0.283 (0.450)	0.294 (0.456)
2	0.160 (0.366)	0.145 (0.352)	0.175 (0.380)
3	0.075 (0.264)	0.064 (0.244)	0.087 (0.282)
≥ 4	0.059 (0.236)	0.048 (0.214)	0.071 (0.256)
Multimorbidiy with depressive disorder			
Cardiovascular diseases	0.026 (0.158)	0.021 (0.145)	0.030 (0.170)
Asthma	0.054 (0.227)	0.031 (0.174)	0.078 (0.268)
Skin cancer	0.013 (0.112)	0.009 (0.093)	0.017 (0.128)
Other types of cancer	0.020 (0.141)	0.013 (0.115)	0.027 (0.163)
COPD	0.027 (0.163)	0.017 (0.131)	0.037 (0.189)
Kidney disorder	0.012 (0.109)	0.008 (0.088)	0.016 (0.127)
Arthritis	0.083 (0.276)	0.051 (0.220)	0.115 (0.320)
Diabetes	0.032 (0.176)	0.025 (0.155)	0.095 (0.195)

Source: 2022 Behavioral Risk Factor Surveillance System (BRFSS) at https://www.cdc.gov/brfss/.
Notes: Standard deviations are in parentheses. Means (%) and standard deviations are weighted by the BRFSS sample weight factor. All means are statistically significant using two tailed t-test with 95% confidence interval.

Among the survey participants, 9.5% did not complete high school, 26.0% were high school graduates, 32.3% had attended some college, and another 32.3% had earned a four-year college degree or more.

According to the study by Hunger et al. (2011), health-related quality of life is non-linearly associated with Body Mass Index (BMI), indicating that the impact of BMI on life satisfaction varies across different BMI levels. This study categorized BMI into four groups: underweight, normal weight, overweight, and obese. BMI is a measure of relative weight for height and is strongly correlated to total body fat. It was calculated by dividing weight (in kilograms) by height (in meters) squared. In the BRFSS, height and weight were reported in feet/inches and pounds, respectively. To convert height to meters, inches were multiplied by 2.54 and then divided by 100. Weight was converted to kilograms by dividing pounds by 2.2. Based on these calculations, 1.6% of respondents were classified as underweight (BMI < 18.50), 28.4% as normal weight (18.50 ≤ BMI < 25.00), 34.8% as overweight (25.00 ≤ BMI < 30.00), and 32.3% as obese (30.00 ≤ BMI). The BRFSS defined exercise as participating in any physical activities or exercises outside of regular job-related tasks within the past month. These activities could include running, calisthenics, golf, gardening, or walking for exercise.

3.3. Chronic Health Conditions

Chronic health conditions are long-term illnesses that persist for a year or more, require ongoing medical attention, and typically cannot be cured. Individuals with chronic health conditions face significantly higher risks of poor health status and unhealthy behaviors, which further complicates effective management. Moreover, chronic health conditions can hinder daily activities, ultimately leading to reduced quality of life and lower life satisfaction (DeWalt et al., 2015; Luo et al., 2015; Froehlich-Grobe et al., 2016; James et al., 2024). Table 3 displays the BRFSS survey questions regarding the 'Chronic Health Conditions' section, which consisted of eleven chronic health conditions: heart attack, coronary heart disease, stroke, asthma, skin cancer, other types of cancer, COPD, depressive disorder, kidney disease, arthritis, and diabetes. This study included all these conditions; however, heart attack, coronary heart disease, and stroke were combined into a single category labeled cardiovascular diseases. Consequently, a total of nine individual chronic health conditions were used in the empirical analyses. The prevalence of these chronic health conditions ranged from 5.9% to 27.6%. The most commonly reported conditions were arthritis (27.6%), depressive disorder (21.3%), asthma (15.1%), and diabetes (12.4%), while skin cancer had the lowest prevalence at 5.9% (Table 4).

3.4. Multiple Chronic Health Conditions

Multimorbidity refers to the coexistence of two or more chronic health conditions within a single individual. Several studies (Chen et al., 2011; Payne et al., 2013; Newman et al., 2017; Castañeda-Avila et al., 2024) have shown that multimorbidity is significantly associated with decreased life satisfaction and a lower health-related quality of life, due to the compounded physical limitations and mental health challenges that arise from managing multiple illnesses simultaneously. In the calculation of the multiple chronic health conditions score, each chronic health condition was dichotomized: one point if a participant responded 'yes' and zero points if they responded 'no' to the respective question. These points were summed to calculate the total number of chronic health conditions reported by each participant (Frey et al., 2015; Larsen et al., 2017; Quah et al., 2017; Son, 2020; Shah et al., 2023). For the analysis, participants were categorized into five groups based on the total number of chronic health conditions they reported: 0, 1, 2, 3, and 4+, with those reporting zero conditions serving as the reference group. Among the respondents, 41.8% reported no chronic health conditions, while 5.9% reported having four or more (Table 4).

3.5. Physical-mental Multimorbidity

A recent study by O'Loughlin et al. (2022) identified a significant interaction between physical and mental health problems, underscoring the high likelihood that individuals with chronic physical conditions also experience mental illness. In other words, individuals with long-term physical health issues frequently experience mental health disorders at the same time. These conditions are interconnected through various pathways. For instance, individuals with depressive disorder may struggle to maintain healthy behaviors, such as regular physical activities and proper nutrition, which can increase their risk of developing chronic physical illnesses. Furthermore, they may be confronted with barriers to accessing healthcare and may encounter various physical and behavioral health complications. This coexistence of chronic health conditions and mental illness can significantly complicate the

management of health issues (National Institute of Mental Health, 2024). These co-occurring conditions often exacerbate one another, resulting in a substantial decline in overall quality of life (Carta et al., 2017).

4. Results

4.1. Descriptive Analysis

Table 2 shows the descriptive statistics for the socio-demographic characteristics. These statistics have been adjusted using sampling weights from the BRFSS. Across all survey participants, 94.4% reported being satisfied with their lives, with no significant differences observed between genders. Among the respondents, 58.7% overall, 61.4% of males, and 55.9% of females reported being married. The proportion of employed individuals was higher among males (66.4%) than among females (55.5%). Approximately 60% of respondents reported an annual household income of $50,000 or more, with a higher proportion of males represented in higher income brackets compared with females. Racially, 61.2% of respondents identified as White, non-Hispanic. As for educational attainment, 64.6% reported having completed some college education or higher. Notably, a higher proportion of female respondents achieved this level of education compared with their male counterparts. In terms of weight classification, 24.7% of male respondents and 32.0% of female respondents were classified as being of normal weight. Conversely, a higher proportion of male respondents (39.6%) were classified as overweight, compared with 29.8% of female respondents. Additionally, a higher percentage of male respondents engaged in physical activities compared with female respondents (80.2% vs. 75.5%).

Table 4 presents descriptive statistics for individual chronic health conditions, the number of chronic health conditions, and the prevalence of physical-mental multimorbidity. Among the reported chronic health conditions, arthritis had the highest prevalence at 27.6%, while kidney disorder had the lowest prevalence at 3.7%. Notably, 27.7% of female respondents reported experiencing depressive disorder compared with only 15.1% of male respondents, indicating that females were nearly twice as likely to report having depressive disorder. Overall, female respondents were more likely than their male counterparts to report suffering from individual chronic health conditions, multiple chronic health conditions, and physical-mental multimorbidity. In contrast, the prevalence of cardiovascular diseases and diabetes was higher among male respondents. Among the combinations of chronic health conditions and depressive disorder examined, the lowest prevalence was observed for the combination of kidney disorder and depressive disorder, reported by only 1.2% of respondents. Conversely, the highest prevalence was found among individuals with both arthritis and depressive disorder, reported by 8.3% of respondents.

4.2. Correlations

The coexistence of two or more chronic health conditions is a common phenomenon among the older population worldwide (Fortin et al., 2007; DeWalt et al., 2015). According to Boersma et al. (2020), more than half (51.8%) of U.S. adults reported having at least one of the chronic conditions, such as arthritis, cancer, chronic obstructive pulmonary disease, coronary heart disease, asthma, diabetes, hepatitis, hypertension, stroke, and weak or failing kidneys. Moreover, 27.7% of adults in the United States experienced multiple chronic conditions, indicating a high likelihood of interaction among these health conditions. Table 5 presents the correlation coefficients among the chronic health conditions. Most of the estimated correlation coefficients were relatively low, ranging from 0.000 (depressive disorder and skin cancer) to 0.250 (between skin cancer and other types of cancer). Cardiovascular diseases exhibited relatively higher correlation coefficients with several other chronic health conditions, with correlation scales exceeding 0.100 for all chronic conditions except asthma and depressive disorder. In contrast, asthma was generally the least correlated with other chronic health conditions.

Table-5. Correlation coefficients among chronic health conditions

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Cardiovascular diseases	(1)	1								
Asthma	(2)	0.045	1							
Skin cancer	(3)	0.104	0.005	1						
Other types of cancer	(4)	0.135	0.019	0.250	1					
COPD	(5)	0.194	0.192	0.074	0.093	1				
Kidney disorder	(6)	0.184	0.040	0.074	0.106	0.106	1			
Arthritis	(7)	0.199	0.099	0.133	0.143	0.197	0.140	1		
Diabetes	(8)	0.198	0.031	0.041	0.071	0.101	0.173	0.174	1	
Depressive disorder	(9)	0.050	0.151	0.000	0.019	0.128	0.054	0.130	0.042	1

Source: 2022 Behavioral Risk Factor Surveillance System (BRFSS) at https://www.cdc.gov/brfss/.

Notes: Correlation coefficients are weighted by the BRFSS sample weight factor. All correlations are significant at the 0.01 level (two-tailed)

4.3. Multiple Logistic Regression Results

This study employs three multivariate logistic regression models to evaluate the impact of chronic health conditions on life satisfaction, controlling for socio-demographic variables. The models examine: (1) individual chronic health conditions, (2) the total number of chronic health conditions, and (3) the presence of physical-mental multimorbidity.

4.3.1. Socio Demographic Variables

Table 6 presents the results of multiple logistic regression analyses incorporating socio-demographic variables and individual chronic health conditions. The findings indicated that being married or employed was significantly associated with higher odds of reporting life satisfaction. Specifically, married individuals had an odds ratio of 2.074 for reporting life satisfaction compared with those who reported a marital status other than 'married,' demonstrating that they were more than twice as likely to report being satisfied with their lives. Furthermore, the positive association between being married and life satisfaction appeared to be more pronounced among male respondents than female respondents, suggesting that gender differences in the influence of marital status on life satisfaction exist.

As people age, their lifestyles often shift toward healthier behaviors, such as consuming a variety of nutritious foods and engaging in regular physical activity. These lifestyle changes can have a significant impact on an individual's physical, mental, and emotional well-being. Research consistently shows a U-shaped or non-linear relationship between age and life satisfaction. Studies (Baird et al., 2010; Sørensen, 2014; Blanchflower et al., 2023) have found that life satisfaction declines from young adulthood into middle age, reaching its lowest point around mid-life (typically in the 40s) before rising again in later years, particularly during retirement. However, the findings of the current study demonstrated a linear relationship between age and life satisfaction. The odds of reporting life satisfaction increased progressively as respondents advanced into older age groups. Using respondents aged 18 to 34 as the reference group, the odds ratios were 1.216 for those aged 35 to 49, 1.587 for those aged 50 to 64, and 2.958 for those aged 65 and older. This increase in the odds of reporting life satisfaction with age was more substantial among male respondents than among female respondents, indicating that the impact of age on life satisfaction was stronger among males.

Table-6. Multiple logistic regression results for life satisfaction by demographic variables

Variables	Overall	Male	Female
Married	2.074 (1.972-2.181)	2.274 (2.117-2.442)	1.862 (1.732-2.002)
Employed	1.421 (1.345-1.501)	1.464 (1.351-1.586)	1.431 (1.325-1.545)
Age group			
Age1834	1	1	1
Age3549	1.216 (1.134-1.302)	1.296 (1.178-1.425)	1.056 (0.953-1.171)
Age5064	1.587 (1.479-1.703)	1.757 (1.592-1.939)	1.344 (1.212-1.491)
Age65+	2.958 (2.731-3.205)	3.236 (2.882-3.633)	2.434 (2.169-2.731)
Income			
Income 25	1	1	1
Income 25-50	1.434 (1.353-1.519)	1.490 (1.366-1.625)	1.425 (1.318-1.541)
Income 50-100	2.012 (1.880-2.153)	2.094 (1.900-2.307)	2.116 (1.921-2.331)
Income 100+	3.098 (2.834-3.386)	3.231 (2.861-3.648)	3.420 (2.991-2.910)
Races			
White, non-Hispanic	1	1	1
Black, non-Hispanic	1.064 (0.980-1.155)	1.083 (0.954-1.229)	0.951 (0.853-1.061)
Hispanic	1.151 (1.062-1.247)	1.135 (1.016-1.268)	1.153 (1.025-1.296)
Others, non-Hispanic	0.924 (0.846-1.009)	0.941 (0.833-1.064)	0.917 (0.807-1.043)
Education			
Less high school	1	1	1
High school graduate	0.954 (0.869-1.047)	0.954 (0.838-1.086)	0.940 (0.822-1.075)
Some college	0.874 (0.797-0.959)	0.863 (0.757-0.984)	0.823 (0.721-0.939)
College graduate	0.977 (0.887-1.076)	0.938 (0.819-1.074)	0.908 (0.790-1.043)
BMI			
Underweight	0.655 (0.567-0.756)	0.594 (0.477-0.740)	0.695 (0.573-0.843)
Normal weight	1	1	1
Overweight	1.051 (0.991-1.115)	1.014 (0.933-1.103)	1.164 (1.070-1.266)
Obese	1.053 (0.995-1.115)	0.937 (0.861-1.020)	1.166 (1.077-1.261)
Exercise	1.729 (1.648-1.814)	1.765 (1.645-1.895)	1.779 (1.665-1.900)

Source: 2022 Behavioral Risk Factor Surveillance System (BRFSS) at https://www.cdc.gov/brfss/.

Notes: Confidence intervals are in parentheses. All of them are statistically significant using two tailed t-test with 95% confidence interval.

The regression results indicated that higher income levels were associated with an increased likelihood of reporting life satisfaction. In comparison, no significant differences were observed across racial and educational categories. Similarly, there was no significant difference in the likelihood of reporting life satisfaction among respondents classified as normal weight, overweight, or obese. However, respondents classified as underweight were significantly less likely to report being satisfied with their lives compared with the other respondents. Physical activity is widely recognized for its positive effects on both physical and psychological health, contributing to overall quality of life. A study by An et al. (2020) explored the relationship between physical activity and life satisfaction. The findings revealed that individuals engaging in physical activity reported significantly greater life satisfaction and happiness compared with those who were inactive. The logistic regression results of the current study also showed that respondents who participated in physical activities were more likely to report being satisfied with their lives.

4.3.2. Individual Chronic Health Conditions

Table 7 presents the results of a multiple logistic regression analysis examining the association between individual chronic health conditions and life satisfaction. Overall, respondents with any chronic health condition were less likely to report being satisfied with their lives. Skin cancer was associated with the least negative impact on life satisfaction among the conditions examined, with an odds ratio of 0.994. In contrast, depressive disorder had the most profound negative impact on individuals' life satisfaction among chronic health conditions, with an estimated odds ratio of 0.249. These findings are consistent with previous studies (Butler et al., 2018; Margolis et al., 2019; O'Loughlin et al., 2022), which have shown that mental health symptoms are more strongly associated with declines in health-related quality of life over time than physical health conditions. No significant gender differences were observed in the impact of chronic health conditions on life satisfaction.

Table-7. Multiple logistic regression results for life satisfaction by individual chronic health conditions

Chronic health conditions	Overall	Male	Female
Cardiovascular Diseases	0.781 (0.733-0.832)	0.825 (0.752-0.905)	0.810 (0.741-0.885)
Asthma	0.877 (0.831-0.926)	0.860 (0.791-0.936)	0.836 (0.778-0.899)
Skin cancer	0.994 (0.909-1.087)	1.085 (0.945-1.247)	0.935 (0.831-1.053)
Other types of cancer	0.964 (0.897-1.035)	0.981 (0.875-1.099)	0.923 (0.842-1.013)
COPD	0.836 (0.782-0.892)	0.862 (0.777-0.957)	0.828 (0.758-0.903)
Kidney disorder	0.850 (0.779-0.928)	0.807 (0.704-0.926)	0.871 (0.775-0.978)
Arthritis	0.847 (0.804-0.892)	0.910 (0.844-0.982)	0.747 (0.695-0.803)
Diabetes	0.882 (0.830-0.938)	0.880 (0.804-0.962)	0.935 (0.858-1.018)
Depressive disorder	0.249 (0.238-0.261)	0.227 (0.213-0.243)	0.233 (0.218-0.249)

Source: 2022 Behavioral Risk Factor Surveillance System (BRFSS) at https://www.cdc.gov/brfss/.
Notes: Confidence intervals are in parentheses. All of them are statistically significant using two tailed t-test with 95% confidence interval.

Table-8. Multiple logistic regression results for life satisfaction by multiple chronic health condition scores

Number of chronic health conditions	Overall	Male	Female
0	1	1	1
1	0.449 (0.419-0.480)	0.441 (0.404-0.481)	0.403 (0.360-0.451)
2	0.301 (0.280-0.324)	0.319 (0.288-0.352)	0.243 (0.217-0.272)
3	0.228 (0.210-0.247)	0.241 (0.214-0.271)	0.182 (0.161-0.206)
≥ 4	0.155 (0.142-0.168)	0.168 (0.148-0.189)	0.122 (0.108-0.138)

Source: 2022 Behavioral Risk Factor Surveillance System (BRFSS) at https://www.cdc.gov/brfss/.
Notes: Confidence intervals are in parentheses. All of them are statistically significant using two tailed t-test with 95% confidence interval.

Table-9. Multiple logistic regression results for life satisfaction by physical-mental multimorbidity

Multimorbidity with depressive disorder	Overall	Male	Female
Cardiovascular Diseases	0.693 (0.636-0.756)	0.657 (0.572-0.755)	0.770 (0.689-0.862)
Asthma	0.633 (0.590-0.678)	0.537 (0.478-0.604)	0.636 (0.582-0.694)
Skin cancer	0.779 (0.689-0.882)	0.882 (0.712-1.093)	0.754 (0.647-0.878)
Other types of cancer	0.834 (0.756-0.921)	0.827 (0.692-0.988)	0.810 (0.719-0.913)
COPD	0.826 (0.758-0.900)	0.889 (0.766-1.031)	0.797 (0.716-0.886)
Kidney disorder	0.795 (0.708-0.892)	0.725 (0.594-0.886)	0.817 (0.709-0.943)
Arthritis	0.449 (0.422-0.479)	0.469 (0.421-0.521)	0.400 (0.368-0.434)
Diabetes	0.705 (0.646-0.765)	0.612 (0.537-0.699)	0.794 (0.714-0.883)

Source: 2022 Behavioral Risk Factor Surveillance System (BRFSS) at https://www.cdc.gov/brfss/.
Notes: Confidence intervals are in parentheses. All of them are statistically significant using two tailed t-test with 95% confidence interval.

4.3.3. Mmultiple Chronic Health Condition Scores

Table 8 shows the results of a multiple logistic regression analysis examining the relationship between the number of chronic health conditions and life satisfaction. The findings revealed that individuals with a higher number of chronic health conditions were significantly less likely to report life satisfaction: the more chronic health conditions individuals had, the lower the estimated odds ratios became. Notably, the odds ratio for respondents with four or more chronic health conditions was 0.155, indicating that these individuals were significantly less likely to report life satisfaction than those with no chronic health conditions.

4.3.4. Physical-Mental Multimorbidity

In Table 7, all individual chronic health conditions were found to have a negative association with life satisfaction. Table 9 presents the interactive effects of combining individual chronic health conditions with a depressive disorder. When comparing the estimated odds ratios of individual chronic health conditions (Table 7) with those for physical-mental multimorbidity (Table 9), the odds ratios for the physical-mental multimorbidity were significantly lower. These findings indicated that the coexistence of chronic health conditions and depressive disorder substantially reduced the likelihood of individuals reporting life satisfaction beyond the impact of a single chronic health condition alone. These interactive effects of physical-mental multimorbidity on life satisfaction were particularly pronounced among individuals with conditions such as arthritis, asthma, and skin cancer. As shown in Table 7, the estimated odds ratio for arthritis alone was 0.847 but dropped significantly to 0.449 when paired with depressive disorder. These findings implied that the negative impact of arthritis on life satisfaction was significantly intensified when a mental health condition was present. Overall, when co-occurring, depressive disorder amplified the negative effects of each chronic physical condition on life satisfaction, with arthritis exhibiting the greatest combined impact.

5. Conclusion and Discussion

Empirical results in this study revealed that the estimated odds ratios for physical-mental multimorbidity were significantly lower than those for individual chronic health conditions. In other words, the co-occurrence of chronic physical conditions and depressive disorder was linked to significantly lower odds of reporting life satisfaction. It reflects that the presence of both a physical and mental health condition has a substantially greater negative impact on life satisfaction than a single condition alone. In particular, arthritis, one of the most prevalent chronic health conditions among adults in the United States (Table 4), emerged as a significant health predictor of reduced life satisfaction. The empirical results showed that respondents with arthritis were less likely to report being satisfied with their lives compared with those without the condition or those with other chronic health conditions. This negative impact was further amplified when arthritis co-occurred with depressive disorder. As shown in Table 7, the odds ratio for arthritis alone was 0.847, already relatively low among the chronic health conditions analyzed. However, when arthritis was accompanied by depressive disorder, the odds ratio dropped sharply to 0.449. This substantial decline highlighted how the coexistence of a mental health condition significantly intensified the adverse effects of arthritis on life satisfaction. A similar pattern was observed for asthma, where the odds ratio decreased from 0.877 (asthma alone) to 0.633 when combined with depressive disorder.

This study has some limitations that should be acknowledged. First, life satisfaction is a subjective measure influenced by an individual's momentary emotional state, which may fluctuate throughout the day. Moreover, because there is no objective standard for quantifying happiness or emotional well-being, self-reported responses may potentially lack consistency or reliability. Second, the failure to account for the severity or duration of chronic

health conditions represents a significant limitation. Individuals with more severe or longer-standing conditions may be less likely to report life satisfaction than those with milder or shorter-term conditions. Supporting this, Busija et al. (2017) found that longer durations of chronic health conditions are associated with poorer health-related quality of life across various physical and mental health conditions. Third, the BRFSS survey included only one mental chronic health condition – depressive disorder. However, different mental illnesses may affect life satisfaction in distinct ways. Moreover, specific mental disorders may interact differently with physical health conditions, leading to varying interactive effects on life satisfaction. These limitations highlight the need for future studies to consider a broader set of mental health conditions to more fully capture the complexity of these interactions.

Chronic diseases are common, many are preventable, and they are closely influenced by health-related behaviors driven by individual choices, such as medication adherence, maintaining a nutritious diet, engaging in regular physical activity, attending medical follow-ups, and avoiding tobacco use. These behaviors not only reduce the risk of developing chronic conditions but also help individuals manage existing illnesses and prevent complications – such as slowing disease progression, minimizing side effects, and reducing disruptions to daily functioning (Helgeson and Zajdel, 2017). Importantly, the primary goal of healthcare for adults with chronic health conditions is to preserve a relatively high quality of life throughout their remaining years (Quah et al., 2017). Based on the empirical findings in the current study, policymakers should prioritize interventions that promote life satisfaction among individuals with multiple chronic health conditions, particularly those who also experience mental health challenges. It is recommended that clinicians routinely screen for and address mental health symptoms, even when they appear mild. Such proactive care is especially important for individuals with co-occurring physical and mental health conditions. In particular, those living with both arthritis and depressive disorder should receive special attention, as they are at a significantly higher risk of reduced life satisfaction.

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