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EVALUATING THE ASSOCIATION OF CANCER-RELATED RISK FACTORS WITH MULTISYSTEM HEALTH: INSIGHTS INTO FERTILITY, CARDIOVASCULAR, AND RENAL INDICATORS

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ABSTRACT

Cancer-related lifestyle and metabolic risk factors, including smoking, alcohol use, physical inactivity, and obesity, are widely recognized for their role in disease development. However, their association with multisystem health outcomes, particularly cardiovascular, renal, and reproductive indicators, remains less clearly characterized in general populations. This cross-sectional study utilized secondary data from the National Health and Nutrition Examination Survey (NHANES). Adult participants aged ≥20 years with complete demographic, clinical, laboratory, and questionnaire data were included (n = 5,588). Cancer-related risk factors were assessed, and outcomes included cardiovascular, renal, and fertility indicators. Statistical analyses included descriptive statistics, group comparisons, and multivariable logistic regression to estimate adjusted associations. A high prevalence of cancer-related risk factors was observed, including smoking, alcohol use, physical inactivity, and obesity. Multisystem abnormalities such as elevated blood pressure, dyslipidemia, and renal impairment were common. Obesity was consistently associated with cardiovascular outcomes and infertility. Smoking was associated with cardiovascular and renal indicators, while physical inactivity was associated with renal impairment. Alcohol use was not significantly associated with outcomes after adjustment. Cancer-related lifestyle and metabolic risk factors were associated with variations in cardiovascular, renal, and reproductive indicators within a general adult population. These findings highlight the presence of overlapping risk factors and multisystem health measures without extending beyond observed associations.

KEYWORDS: Cancer-related risk factors; Obesity; Cardiovascular health; Renal function; Fertility

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1. INTRODUCTION

Lifestyle and metabolic risk factors associated with cancer are becoming more and more identified with implications extending beyond the oncologic outcomes of cancer, especially as far as the health of the system is concerned. There is an increasing amount of evidence that obesity, smoking, physical inactivity, and the maladaptation of metabolic processes among other conditions are not merely related to the risk of cancer but also to changes in various physiological systems. Particularly, these interactions become particularly topical within the framework of cardiovascular and metabolic diseases with overlapping risk profiles, which is common in the context (Boudoulas et al., 2022). Equally, molecular and clinical research has called into the spotlight the influence of systemic processes, such as inflammation, metabolic disequilibrium, and cellular signaling pathway, on diseases progression in various organ systems (Cui et al., 2024; Delshad et al., 2025). The combination of genetic, metabolic, and environmental causes also confirms the idea that health outcomes are determined by the intertwined biological processes instead of the single processes of diseases (Balinisteanu et al., 2024; Battle et al., 2025). Also, new views on cardio-oncology and immune-related diseases highlight the interactions between the exposures caused by cancer and cardiovascular health throughout the lifespan (Chen and Epstein, 2023; Brahmer et al., 2021). The fact that gender disparity and population-wide variation in health data shows that the effects of risk factors on different people may not be equally prevalent also supports the need to conduct detailed, population-wide analyses (Carà, 2022).

In spite of these developments, there are still significant gaps in the comprehension of how risk factors linked to cancer are linked to multisystem health outcomes in general population. The literature is frequently concentrated on specific clinical groups or individual disease outcomes, which is why it does not allow capturing the systemic patterns (Du Plessis et al., 2025). Moreover, although metabolic dysfunction has been associated with multi-organ dysfunction (liver disease and cancer development), it is less well-defined in the context of combined cardiovascular, renal, and reproductive dysfunction (Du et al., 2025; Ma et al., 2025). The idea of organ crosstalk, especially between metabolic and reproductive systems, has recently experienced an increase of studies, but the realization of this unity at the population level is still scarce (Huang et al., 2025). Along with it, environmental and lifestyle exposures, such as dietary and behavioral factors, still pose complicated and occasionally incongruent relationships with systemic health results (Mafe & Busselberg, 2025). These gaps serve to indicate the necessity of complete analyses that take into consideration numerous risk factors together with health systems in a single framework.

This paper fills these gaps by considering the relationship between lifestyle and metabolic risk factors related to cancer and cardiovascular, renal, and fertility variables in a large, nationally representative population of adults. This study includes several elements of data, such as demographic, clinical, lab, and questionnaires data, to offer in-depth measurements of multisystem health. The advantage of this method is that much larger patterns of association across different physiological areas can be assessed as opposed to studies that concentrate on particular diseases. The splicing of fertility related indicators also takes the analysis further to the area of reproductive health that is usually underrepresented in research on systemic risk factors. Past studies have shown that metabolic and physiological factors are significant in the reproductive outcomes, such as infertility and hormonal control (Mittal et al., 2017). Likewise, it has been observed that metabolic and cardiovascular conditions are associated with more general chronic disease trends, which makes it clear that it is important to analyze the relationship between these two conditions in a homogeneous environment (Młynarska et al., 2025). There have been clinical and therapeutic studies on the importance of considering systemic effects when assessing the disease pathways and responses to treatment (Orasan et al., 2018; Ranasinghe et al., 2022).

According to this argument, the current research seeks to create a contribution to the knowledge on how prevalent risk factors related to cancer are linked to quantifiable changes in various health areas in a general adult population.

Research Objectives

1. To assess the distribution of cancer-related lifestyle and metabolic risk factors in an adult population.
2. To evaluate the association of these risk factors with cardiovascular and renal health indicators.
3. To examine the relationship between these risk factors and fertility-related outcomes among women of reproductive age.

2. METHODOLOGY

2.1 Study Design and Data Source

This study used an analytical study design of

secondary data, which was readily available in the forms of the National Health and Nutrition Examination Survey (NHANES) of the Centers of Disease Control and Prevention (CDC) and the National Center of Health Statistics (NCHS). The data was retrieved through the Kaggle service (Centers for Disease Control and Prevention [CDC] & National Center for Health Statistics [NCHS], 2017). NHANES also covers demographic, clinical, laboratory, dietary, and questionnaire data, which were combined with the use of the unique participant identifier (SEQN) to evaluate risk factors related to cancer and to determine that they are associated with multisystem health outcomes.

2.2 Study Population

Adult individuals with a minimum age of 20 years who had full details of demographic, examination, laboratory, and the questionnaire variables were included in the study. The final sample of analysis included 5,588 individuals after the application of the inclusion criteria and used datasets were merged. Participants whose key outcome variables could not be located or whose data set could not be linked were rejected.

2.3 Cancer-Related Risk Factors

The risk factors related to cancer were operationalized using the existing epidemiological evidence and covered smoking status (ever and current), alcohol use, physical inactivity, and obesity (BMI ≥30 kg/m^2). These were the variables that were obtained based on the data collected in the questionnaire and examinations and reflect major modifiable exposure linked with cancer risk.

2.4 Outcome Measures

Outcomes were chosen to depict the multisystem domains of health such as cardiovascular, renal as well as reproductive indicators. The cardiovascular outcomes were high blood pressure, dyslipidemia, and self-reported hypertension. The renal outcomes were serum creatinine, urine albumin to creatinine ratio (ACR), and renal impairment in terms of clinical thresholds. The fertility outcomes were determined in the older age bracket of 20-44 years of age and comprised of ever pregnancy, current pregnancy, infertility and contraceptive use and hormone use.

2.6 Statistical Analysis

Continuous variables were reported in the form of the mean and standard deviation and also frequencies and percentages where categorical variables were reported. Independent t-tests were used to compare the groups on continuous variables and chi-square tests were used to compare the groups on categorical variables. The odds ratios (ORs) with 95% confidence intervals (CIs) to examine the relationship between cancer-related risk factors and cardiovascular, renal, and fertility outcomes were estimated using multivariable logistic regression models adjusting the age, sex, and other covariates.

3. RESULTS

3.1 Adult Analytic Sample and Baseline Multisystem Profile

The final analytic sample (n=5,588) was obtained by combining demographic, examination, laboratory, diet, and questionnaire data by the unique participant identifier (SEQN) and was limited to adults aged 20 years or older. The sample population comprised of a heterogeneous adult population group characterized overall by an overweight to obese profile. Blood presure showed that there was an oscillation between normal and high ranges, but lipid levels showed the possibility of moderate dyslipidemia. Renal indicators and glycemic indicators also proved to be varied in baseline kidney functioning and metabolic condition. In general, these results indicate quantifiable cardiometabolic and renal deviation of the study population (Table 1).

Table 1. Baseline clinical and biochemical characteristics of the adult analytic sample

Variable	Overall	Female	Male	p-value
Age (years)	49.2 ± 17.5	49.3 ± 17.5	49.0 ± 17.6	0.511
BMI (kg/m^2)	29.1 ± 7.2	29.7 ± 7.9	28.5 ± 6.2	<0.001
Waist circumference (cm)	99.2 ± 16.6	97.8 ± 17.1	100.7 ± 15.9	<0.001
Systolic BP (mmHg)	123.4 ± 18.0	121.8 ± 19.0	125.2 ± 16.7	<0.001
Diastolic BP (mmHg)	70.1 ± 11.4	69.0 ± 10.9	71.2 ± 11.8	<0.001
Total cholesterol (mg/dL)	189.1 ± 41.9	192.4 ± 42.3	185.6 ± 41.0	<0.001
HDL cholesterol (mg/dL)	52.8 ± 16.1	57.3 ± 16.4	47.9 ± 14.3	<0.001
LDL cholesterol (mg/dL)	111.0 ± 35.2	111.0 ± 35.1	110.9 ± 35.3	0.968
Triglycerides (mg/dL)	120.9 ± 124.7	111.4 ± 132.7	131.1 ± 114.5	<0.001
Serum creatinine (mg/dL)	0.9 ± 0.5	0.8 ± 0.5	1.0 ± 0.6	<0.001
Albumin–creatinine ratio (mg/g)	48.2 ± 328.6	34.5 ± 228.6	62.9 ± 408.3	0.002
HbA1c (%)	5.7 ± 1.1	5.7 ± 1.1	5.8 ± 1.1	0.063

3.2 Distribution of Cancer-Related Lifestyle and Metabolic Risk Factors

Behavioral and metabolic risk factors of cancer

were very prevalent. All in all, 43.7% of the respondents had ever smoked and 20.5% were current smokers, and their use of alcohol was 72.0%. According to a combined definition of physical inactivity, 26.1% of them were inactive. Participants with obesity (BMI ≥30 kg/m^2) were 37.7%. Men were more likely to smoke and consume alcohol compared to women who were more likely to be physically inactive and obese. These results point to the same population clustering of modifiable cancer-related risk factors (Table 2).

Table 2. Distribution of cancer-related lifestyle and metabolic risk factors

Variable	Overall n (%)	Female n (%)	Male n (%)	p-value
Ever smoker	2443 (43.7)	1044 (35.8)	1399 (52.4)	<0.001
Current smoker	1147 (20.5)	527 (18.1)	620 (23.2)	<0.001
Alcohol use	3666 (72.0)	1625 (61.7)	2041 (82.9)	<0.001
Physically inactive	1461 (26.1)	903 (30.9)	558 (20.9)	<0.001
Obesity	2083 (37.7)	1211 (42.0)	872 (33.1)	<0.001

The sex-specific stratified distribution of lifestyle and metabolic risk factors of cancer is in Figure 1.

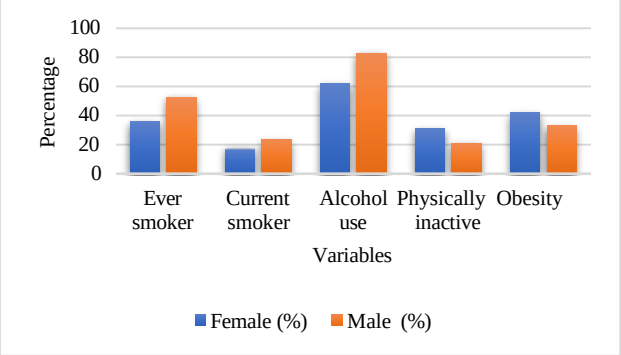


Figure 1. Sex-wise distribution of cancer-related risk factors

The distribution of smoking and alcohol consumption is greater in males, and the levels of physical inactivity and obesity in females are higher, which displays sex differences in the risk factors pattern.

3.3 Multisystem Health Burden: Cardiovascular and Renal Indicators

Multisystem abnormalities were prevalent. High blood pressure was observed in 36.7%, dyslipidemia was in 76.1%, and renal impairment was in 17.6% of the research subjects. Men were found to be more affected by high blood pressure and women were slightly affected by dyslipidemia. There was no significant sex difference in renal impairment. Also, 37.4% of them were hypertensive and 12.7% were diabetic, which showed that chronic disease existed in high correlation with cancer-related exposures (Table 3).

Table 3. Multisystem health indicators

Variable	Overall n (%)	Female n (%)	Male n (%)	p-value
Elevated blood pressure	1975 (36.7)	928 (31.7)	1047 (40.5)	<0.001
Dyslipidemia	3239 (76.1)	1802 (78.4)	1437 (73.3)	<0.001
Renal impairment	936 (17.6)	487 (17.6)	449 (17.7)	0.945
Hypertension (self-reported)	2090 (37.4)	1128 (38.6)	962 (36.1)	0.048
Diabetes	707 (12.7)	364 (12.5)	343 (12.9)	0.709

The variation in cardiovascular, metabolic, and renal burden was also assessed using sex-based differences in the multisystem health indicators as shown in Figure 3.

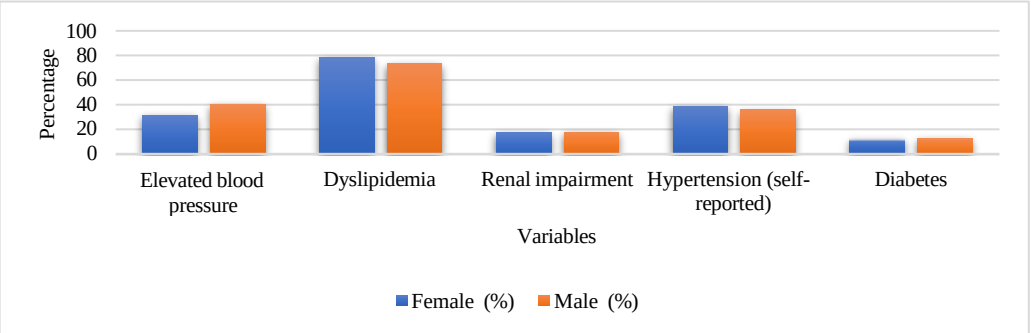


Figure 3. Sex-wise distribution of health indicators

Dyslipidemia was the most prevalent in both genders as indicated in Figure 3 with the values being a bit higher in the female group. High blood pressure and hypertension were more prevalent in males whereas renal impairment and diabetes were relatively similar in their distributions in the sexes.

3.4 Adjusted Associations with Cardiovascular and Renal Outcomes

Obesity turned out to be the most potent predictor of cardiovascular risk in multivariate analyses, with the odds ratios of both conditions being high, namely blood pressure (OR 1.85, 95% CI 1.612.11) and

dyslipidemia (OR 2.08, 95% CI 1.752.47). Elevated blood pressure, dyslipidemia and renal impairment were associated with current smoking independently and physical inactivity was associated significantly with renal impairment. No significant outcome adjustment was found in relation to alcohol use. These results indicate that the risk factors of cancer have a different but overlapping effect on the different organ systems (Table 4).

Table 4. Adjusted associations with cardiovascular and renal outcomes

Outcome	Smoking OR (95% CI)	Alcohol OR (95% CI)	Inactivity OR (95% CI)	Obesity OR (95% CI)
Elevated BP	1.31 (1.10–1.55)	0.94 (0.80–1.09)	0.91 (0.78–1.07)	1.85 (1.61–2.11)
Dyslipidemia	1.41 (1.14–1.73)	0.98 (0.82–1.18)	1.05 (0.87–1.27)	2.08 (1.75–2.47)
Renal impairment	1.32 (1.06–1.64)	0.92 (0.76–1.12)	1.26 (1.05–1.51)	1.15 (0.97–1.37)

3.5 Fertility-Related Indicators in Women of Reproductive Age

Out of 1, 262 ladies between 20 and 44 years, 73.3% ladies had ever been pregnant, 12.4% ladies had difficulty conceiving, and 67.1% ladies had used contraceptives. There was low usage of hormones (3.2%), with 5.2 percent being in pregnancy. These results indicate that the reproductive variables have been well represented to conduct fertility analysis (Table 5).

Table 5. Fertility-related indicators

Indicator	n/N (%)
Ever pregnant	811/1106 (73.3)
Current pregnancy	65/1262 (5.2)
Infertility	137/1106 (12.4)
Oral contraceptive use	741/1104 (67.1)
Hormone use	35/1105 (3.2)

Fertility indicators were made on women in the reproductive age to determine the pattern of reproductive health as indicated by Figure 4.

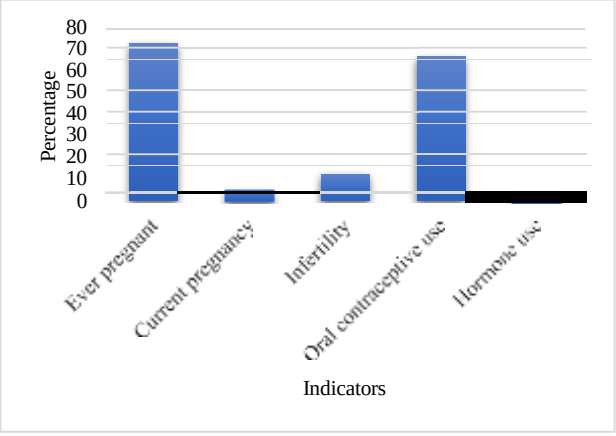


Figure 4. Fertility-related indicators

As indicated in Figure 4, most of the women were found to have been pregnant with infertility and current pregnancy being lower. The use of oral contraceptives was relatively high and relatively low in the use of hormones.

3.6 Adjusted Associations with Fertility Outcomes

Obesity had the sole and significant impact on infertility in adjusted models (OR 1.97, 95% CI 1.34–2.90). There was no significant correlation between smoking, alcohol and inactivity. Previously pregnancy was mainly age-related and the present pregnancy had no risk factors affiliation. The results mean that behavioral exposures lose out to metabolic factors in relation to reproductive outcomes (Table 6).

Table 6. Adjusted associations with fertility outcomes

Outcome	Smoking OR (95% CI)	Alcohol OR (95% CI)	Inactivity OR (95% CI)	Obesity OR (95% CI)
Ever pregnant	1.48 (0.96–2.30)	0.88 (0.61–1.25)	1.43 (0.95–2.15)	0.94 (0.67–1.32)
Current pregnancy	0.54 (0.23–1.26)	0.66 (0.37–1.18)	0.82 (0.40–1.69)	1.02 (0.56–1.86)
Infertility	0.85 (0.51–1.40)	1.27 (0.84–1.94)	1.21 (0.78–1.87)	1.97 (1.34–2.90)

4. DISCUSSION

The study has investigated how cancer-related lifestyle and metabolic risk factors relate to multisystem health outcomes (cardiovascular, renal and fertility outcomes) in a large adult cohort. The findings indicate that there is a large proportion of modifiable risk factors such as smoking, alcohol use, lack of physical activity and obesity in addition to a significant burden on the cardiovascular and renal abnormalities. These findings suggest that these risk factors are usually widespread and co-exist with quantifiable differences in various physiological systems. The demographic traits of the research sample indicate an overall profile of overweight individuals, with lipid and renal differences. These cases of moderate dyslipidemia and variation in renal parameters indicate that there is some heterogeneity in the cardiometabolic health of the population. Moreover, the risk factors are clustered as a considerable number of people were exposed to more than one risk factor, including smoking, alcohol, and obesity. This clustering is significant, because it implies that people tend to be exposed to

multiple risk factors at the same time, and not to single ones. The researchers found out that the level of multisystems abnormalities such as hypertension, dyslipidemia, and kidney impairment were quite high. These results emphasize the fact that changes in cardiovascular and renal outcomes are frequent in populations with the high level of lifestyle and metabolic risks. The presence of hypertension and diabetes as self-reported also supports the fact that the same group of people may have more than one chronic condition. It was also found that there are sex-based differences in the distribution of risk factors and that there are more men smokers and alcohol users and more obese and physically inactive women. Such differences could indicate biochemical and behavioral differences in sexes. Obesity in adjusted analysis was always related to cardiovascular results, such as high blood pressure and dyslipidemia. This implies that cardiovascular indicators in this population can be significantly altered with an increase in body mass. High blood pressure, dyslipidemia, and renal impairment were also linked with smoking, which suggests that smoking has a wider relationship with the cardiovascular and renal indicators. Physical inactivity was significantly related to renal impairment, and it is possible that a connection exists between low physical activity and kidney-related outcomes. Conversely, after controlling, alcohol consumption was not found to be significantly correlated with these outcomes, which showed that its correlation with these indicators might not be as uniform in this sample. Fertility-related results also continue the analysis to reproductive results. Obesity was found to have increased chances of infertility in women who had reproductive age, whereas there was no significant association with other risk factors. These findings indicate that the relationship between body weight and other metabolic factors and fertility indicators can be stronger than those between behavioral factors and fertility indicators in this group. The absence of significant relationships between current pregnancy or ever pregnancy might indicate that there are other factors that could have affected these outcomes, not conserved in the current analysis.

The results of the present paper are in line with the work done by other researchers that determined the connection between metabolic and lifestyle factors and overall health outcomes. Indicatively, Wan et al. (2025) indicated variations in reproduction related to metabolic and clinical factors, showing the applicability and utility of underlying health status in fertility-related indicators. Likewise, Zhu and Zhang (2025) showed that early nutritional influences occur in the early stages of life that can cause health risks in the long-term and metabolic factors are the cause of this disease development. Other studies, which have been carried out by Zhou et al. (2025), have also highlighted the interaction of metabolic and renal processes, which point to common mechanisms of action of the organ systems. Besides, Wang et al. (2024) have outlined the potential effects of systemic processes on biological disease pathways in various fields. These studies favor the observation that lifestyle and metabolic variables are associated with an outcome beyond one system.

The implications of the findings include the role of modifiable risk factors in populations in terms of their distribution and effects. These exposures were found to be very high, indicating that greater preventive measures that cover various risk factors are required. The consistent correlation of obesity with multiple outcomes suggests that it might become a valuable factor to take into consideration in the health evaluation of the population at a larger scale. Moreover, the multisystem indicators in the same population point to the interrelationship between health outcomes. There are several restrictions that can be taken into consideration. The cross-sectional design does not provide the opportunity to develop the causal linkage between risk factors and outcomes. There might be reporting bias in self-reported variables, including smoking and physical activity. Moreover, the secondary data is used to conduct the analysis, and it might not cover all the variables that have any effect on the observed associations. The lack of direct cancer outcomes implies that the results can only be restricted to the risk factors of cancer and not the occurrence of cancer itself.

Longitudinal designs can be used in future research in order to learn more about the temporal connection between these risk factors and multisystem outcomes. Additional variables and interaction effects could also be investigated using more research in order to more effectively describe the relationships that have been identified in this study.

5. CONCLUSION

This study gives a detailed evaluation of the relationship between cancer-related lifestyle and metabolic risk factors and multisystem health indicators in a vast adult cohort. The results indicate a strong percentage of risk factors that can be altered in the form of smoking, alcohol consumption,

physical inactivity, and obesity, and significant differences between cardiovascular, renal, and reproductive outcomes. The major results suggest that obesity was always linked to poor results in a multiplicity of systems, such as increased blood pressure, dyslipidemia, and infertility, which implies that it is the central factor affecting the overall health condition. Both cardiovascular and renal indicators had also been linked to smoking whereas physical inactivity had a significant correlation with renal impairment. Another point is that alcohol use disparate associations were not shown to be consistent; however. These findings highlight the difference in the effects of different risk factors on organ systems. The paper has also found a significant weight of multisystem pathophysiology, such as high blood pressure, dyslipidemia, and renal dysfunction, and significant sex-specific disparities in the distribution of risk factors. The analysis on fertility also suggested that metabolic factors, especially obesity, tend to correlate better with infertility than behavioral exposures. In general, the results indicate that risk factors of cancer are associated with quantifiable changes in various physiological areas. These findings underline the need to have modifiable risk factors tackled in an integrated way so as to gain a better insight into the wider health implications of these factors.

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