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# Disparities in Albuminuria Prevalence and Associated Risk Factors Among Adults: a Population-Based Study

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**Abstract:**

Albuminuria is an early sign of damage to the kidney, as well as a significant predictor of negative kidney and cardiovascular outcomes. As much as this is of interest in terms of population health, the recent population-level information regarding the differences in albuminuria and its risk factors is limited. This study aimed to assess the prevalence of albuminuria and identify its sociodemographic and metabolic correlates among adults in a population-based setting. A cross-sectional analytical approach was used, including 5,443 adults aged 20 years and older. Albuminuria was defined as a urine albumin-to-creatinine ratio of at least 30 mg/g. Descriptive statistics were used to summarize participant characteristics, while group differences were assessed using appropriate statistical tests. Multivariable logistic regression was conducted to identify independent associations. The prevalence of albuminuria was 11.28%, with a marked increase across age groups, ranging from 4.60% in younger adults to 16.00% among those aged 60 years and older. Higher prevalence was observed among males, individuals with lower income, and certain racial and ethnic groups. In adjusted analysis, older age, low income, and higher serum creatinine were independently associated with albuminuria, while uric acid demonstrated a borderline association. These findings indicate that albuminuria is influenced by both biological and socioeconomic factors. Albuminuria affects a substantial proportion of adults and reflects underlying disparities in kidney health. Strengthening early detection strategies and addressing social determinants of health are essential to reduce the burden of kidney disease and improve population health outcomes.

**Keywords:** albuminuria, chronic kidney disease, health disparities, socioeconomic factors, population health

## 1. Introduction

Chronic kidney disease (CKD) is now a significant health issue of global concern, with vast morbidity, mortality and healthcare burden in the world. The epidemiology of CKD has been steadily rising over the past decades, due to the effects of the rise in non-communicable diseases and demographic changes (Lv & Zhang, 2019). Nowadays, CKD is considered one of the most significant causes of diminished quality of life and premature mortality worldwide, and it has vast health system and resource allocation implications (Cockwell & Fisher, 2020). The latest systematic reviews globally also indicate the growing magnitude of the CKD burden, which is becoming a more significant health agenda across the world (Jadoul et al., 2024). Besides its clinical outcomes, CKD has a significant economic impact, and the long-term cost management, dialysis, and transplantation can be expensive (Silva Junior et al., 2018). This will be further increased by population ageing, as older adults are more prone to kidney dysfunction and other related complications (Boettiger et al., 2023). Albuminuria has become a highly important indicator of early kidney damage and a significant element in the detection of people at risk. Albuminuria, which is usually measured as the ratio of urine albumin to creatinine (ACR), represents changes in the permeability of the glomeruli and is an early sign of renal damage (Résimont et al., 2022). In addition to having a diagnostic significance, albuminuria bears significant prognostic consequences, since it is closely linked to cardiovascular outcomes and general mortality (Ruilope et al., 2023). It is also shown that albuminuria is associated with the gradual deterioration of kidney function in the presence of no apparent kidney disease, demonstrating its potential in early risk identification (Verma et al., 2024). Consequently, albuminuria has been given center stage in prevention, early intervention and risk stratification of kidney disease. The determinants of albuminuria have been explored in a growing body of literature, with some of the determinants being biological and social factors leading to the development of albuminuria. The conventional risk factors, age and metabolic abnormalities, are still significant, but more recently, there is also growing attention to the social determinants of health. The rise in the risk of albuminuria and poor kidney prognosis has been associated with socioeconomic deprivation, poor access to medical care, and more systemic inequalities (Huang et al., 2024). Social deprivation is associated with the increased risk of progression of kidney disease and is shown in the European populations, which underlines the importance of the contextual and environmental variables (Casey et al., 2024). These results indicate that albuminuria is not only a clinical phenomenon but also a presentation of the existing health disparities among populations. At the population level, there is increasing interest in the role of albuminuria screening as an early detection and prevention tool of CKD. The screening programs can detect people who are at risk even before they develop advanced disease, thus providing opportunities to take timely interventions and enhance the long-term outcomes (Lamprea-Montealegre & Estrella, 2023). The systematic review evidence shows that the burden of CKD differs significantly according to categories based on the glomerular filtration rate and albuminuria, which supports the significance of including albuminuria in the overall risk assessment models (Murton et al., 2021). With these improvements, there has been a poor uptake of effective population-level interventions, especially in the light of changing demographic and epidemiological trends. Despite the fact that the current literature has presented some significant knowledge on the epidemiology of albuminuria and CKD, there are still gaps. Most studies have been done on clinical/disease-specific populations, which could hamper generalization of the findings to the wider population. Also, the past studies have tended to study the biological or social determinants separately, as opposed to combining the factors into one analytical framework. It is also necessary to have newer evidence that covers the current population dynamics and describes the sociodemographic disparities as well as the metabolic risk factors holistically. In this regard, the current research proposal will address the inequalities in the prevalence of albuminuria and the identification of the sociodemographic and metabolic risk factors in a population-based cohort of adults. The study aims at estimating the prevalence of albuminuria, determining differences between major population subgroups, and determining independent relationships by multivariable analysis. This study incorporates both clinical and social determinants, which offer corresponding evidence to support specific interventions in promoting the health of the population in relation to the kidneys and helps to address the gap in reducing disparities in kidney health.

## 2. Methodology

### 2.1 Research Design

This research used a cross-sectional type of analytical design to investigate the prevalence of albuminuria and the sociodemographic and metabolic factors related to albuminuria among adults. The cross-sectional design is suitable for the estimation of prevalence in the population and for determining the relationships between exposure factors and health outcomes at one time.

### 2.2 Data Source

The sources used were the National Health and Nutrition Examination Survey (NHANES), which is a national survey conducted by the Centers for Disease Control and Prevention (CDC) through the National Center for Health Statistics (Centers for Disease Control and Prevention, 2023). NHANES is constructed to evaluate the health and nutritional conditions of the non-institutionalized civilian population in terms of a set of structured interviews, physical examinations, and laboratory tests. The 2021-2023 cycle will use revised sampling plans and revised procedures in response to the COVID-19 pandemic to maintain the representativeness and quality of data.

### 2.3 Study Population

Adults who were 20 years and above were considered to be the study population. The participants of the study were included when they had full information on urinary albumin-creatinine ratio and the most important covariates, including demographic and biochemical variables. Persons who lacked values in these variables were not included in the final analysis, thus having a complete-case analytical sample.

### 2.4 Variables and Measurements

The most common finding was albuminuria, which was measured in terms of the urine albumin-to-creatinine ratio (ACR). Participants who had an ACR 30mg/g and above were included as having albuminuria, which aligns with the clinical definition of kidney damage. Sociodemographic variables were age (both continuous and categorical), sex, race/ethnicity, and income level according to the poverty-income ratio. Metabolic variables were serum creatinine and serum Uric acid levels, which were obtained with the help of laboratory measurements. The choice of all variables was made according to their proven applicability in terms of kidney health and risk assessment on a population level.

### 2.5 Data Management

Merging data files was done with unique identifiers of the participants to form a single analytical dataset. To produce categorical variables where necessary, variable recoding was done. The complete-case method was used, omitting those observations where the variables of interest had missing values, so as to maintain consistency in the statistical modelling.

### 2.6 Statistical Analysis

Participant characteristics were summarized using descriptive statistics. Continuous variables were given in the form of mean and standard deviation, whereas categorical variables were in the form of frequencies and percentages. The independent t-tests of continuous variables and the chi-square tests of categorical variables were used to test the differences between groups. Multivariate logistic regression analysis was used to determine the independent factors that are related to albuminuria. Findings were presented in adjusted odds ratios (AORs) with 95% confidence intervals (CIs). The statistical significance was considered a two-sided p-value that is less than 0.05.

## 3. Results

### 3.1. Study Population Characteristics

A total of 5,443 adults were included in the final analysis after the exclusion of individuals who lacked data on important variables. Of these, 614 individuals (11.28%) were categorized as having albuminuria. The mean age of participants was 54.0 ± 17.0 years, and 54.9 % were women. Participants with albuminuria where older albuminuria was significantly higher (mean 62.3 years, SD 14.6) as compared to those who did not have albuminuria (mean 52.9 years, SD 17.0) ($p < 0.001$). The mean serum creatinine was greater in the presence of albuminuria (1.05 mg/dL) than in the absence of albuminuria (0.88 mg/dL), and the same trend was followed by the uric acid levels (5.43 mg/dL and 5.13 mg/dL, respectively) (both $p < 0.001$). There

were also sociodemographic differences. The percentage of those people who had albuminuria was higher in the age group of 60 years and above (65.0%), whereas the percentage of those individuals who did not exhibit albuminuria was 43.4%. Albuminuria (22.1% )were of lower income groups when compared to 17.5% of those without albuminuria. The proportion of males was higher in people with albuminuria (51.0%) compared to people without albuminuria (44.4%). The difference between variables was statistically significant in all variables under study. Table 1 summarizes the study population stratified according to the albuminuria status.

**Table 1. Participant characteristics by albuminuria status**

| Variable | Category | No albuminuria (n=4829) | Albuminuria (n=614) | p-value |
|---|---|---|---|---|
| Age (years) | __ | 52.94 ± 17.04 | 62.32 ± 14.58 | <0.001 |
| Serum creatinine (mg/dL) | — | 0.88 ± 0.30 | 1.05 ± 0.86 | <0.001 |
| Uric acid (mg/dL) | — | 5.13 ± 1.39 | 5.43 ± 1.58 | <0.001 |
| Albumin-creatinine ratio (mg/g) | — | 8.83 ± 6.01 | 242.34 ± 850.35 | <0.001 |
| Sex | Female | 2685 (55.6%) | 301 (49.0%) | 0.002 |
| | Male | 2144 (44.4%) | 313 (51.0%) | |
| Age group | 20–39 | 1307 (27.1%) | 63 (10.3%) | <0.001 |
| | 40–59 | 1427 (29.6%) | 152 (24.8%) | |
| | ≥60 | 2095 (43.4%) | 399 (65.0%) | |
| Income group | High | 3982 (82.5%) | 478 (77.9%) | 0.006 |
| | Low | 847 (17.5%) | 136 (22.1%) | |
| Race/ethnicity | Mexican American | 329 (6.8%) | 35 (5.7%) | <0.001 |
| | Non-Hispanic Black | 523 (10.8%) | 104 (16.9%) | |
| | Non-Hispanic White | 2930 (60.7%) | 334 (54.4%) | |
| | Other Hispanic | 499 (10.3%) | 59 (9.6%) | |
| | Other Race | 548 (11.3%) | 82 (13.4%) | |

### 3.2. Prevalence of Albuminuria Across Population Subgroups

The rate of albuminuria was not uniformly distributed among sociodemographic groups (Table 2). There was a clear age gradient, with the prevalence of 4.60% among the 20-39 years of age recording high to 16.00% among those aged 60 years and above ($p < 0.001$). This trend is shown in Figure 1 that shows a gradual increase in the prevalence of albuminuria among age groups.

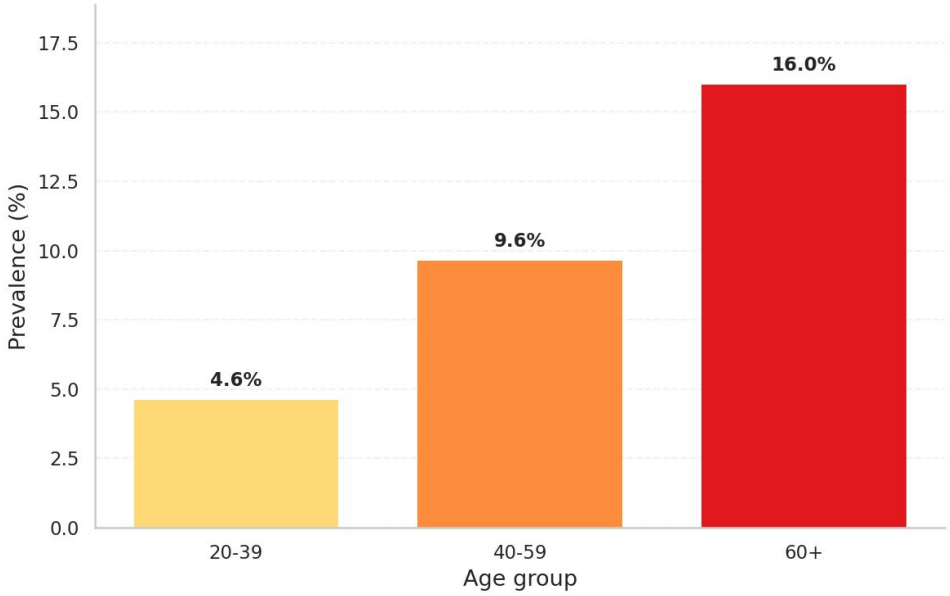


**Figure 1: Prevalence of albuminuria across age groups among U.S. adults, NHANES 2021–2023**

Sex differences were found as well, with a higher prevalence rate of the male sex (12.74%) in comparison with the female sex (10.08%) (p = 0.002). Disparities were evident regarding the socioeconomic background because the prevalence was higher among low-income individuals (13.84%) than among high-income individuals (10.72%) (p = 0.006). There were significant variations between racial and ethnic groups. The prevalence was highest in non-Hispanic blacks (16.59%), then there were the other races (13.02%), and the least prevalent were the Mexican Americans (9.62%). These differences are graphically illustrated in Figure 2.

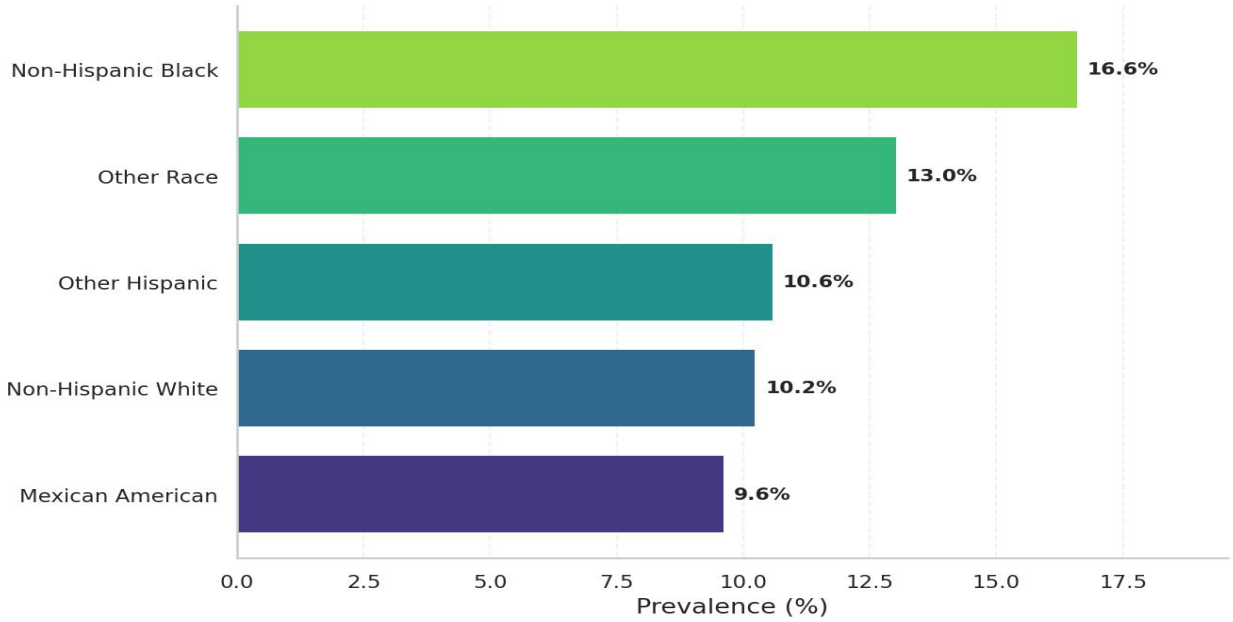


**Figure 2: Prevalence of albuminuria by race and ethnicity among U.S. adults, NHANES 2021–2023**

**Table 2. Prevalence of albuminuria across sociodemographic groups**

| Variable | Category | Total (n) | Albuminuria (n) | Prevalence (%) | p-value |
|---|---|---|---|---|---|
| Sex | Female | 2986 | 301 | 10.08 | 0.002 |
| | Male | 2457 | 313 | 12.74 | |
| Age group | 20–39 | 1370 | 63 | 4.60 | <0.001 |
| | 40–59 | 1579 | 152 | 9.63 | |
| | ≥60 | 2494 | 399 | 16.00 | |
| Income group | High | 4460 | 478 | 10.72 | 0.006 |
| | Low | 983 | 136 | 13.84 | |
| Race/ethnicity | Mexican American | 364 | 35 | 9.62 | <0.001 |
| | Non-Hispanic Black | 627 | 104 | 16.59 | |
| | Non-Hispanic White | 3264 | 334 | 10.23 | |
| | Other Hispanic | 558 | 59 | 10.57 | |
| | Other Race | 630 | 82 | 13.02 | |

### 3.3. Multivariable Analysis of Factors Associated with Albuminuria

The results of the multivariate logistic regression analysis (Table 3) revealed that there are factors that were independently related to albuminuria. The association of age was strong and consistent with each one-year increase in age associated with a 3.8% increase in odds of albuminuria per one year (AOR = 1.04, 95% CI: 1.03-1.04, p < 0.001). This association is also demonstrated in Figure 3, whereby the predicted probability of albuminuria increases progressively with increasing age.

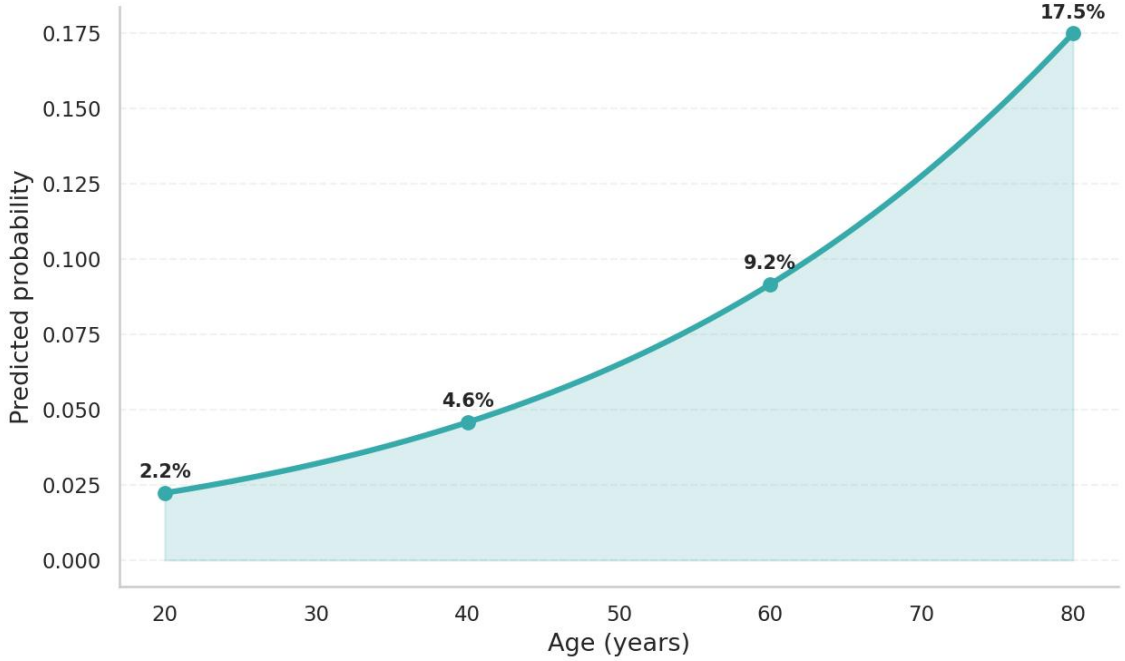


**Figure 3: Adjusted predicted probability of albuminuria by age based on multivariable logistic regression**

The independent relationship between low income and albuminuria (AOR = 1.32, 95% CI: 1.06-1.64, p = 0.013) also shows that even after the clinical factors, the socioeconomic disparity was still present. Serum creatinine was strongly correlated (AOR = 1.57, 95% CI: 1.27-1.94, p < 0.001) with biochemical markers and uric acid was borderline correlated (AOR = 1.06, p = 0.067). The independent effects of sex

and race/ethnicity on albuminuria were not found to be significantly related to albuminuria when adjusted, and the crude differences could have been attributed to demographic and metabolic differences.

**Table 3. Multivariable logistic regression analysis of factors associated with albuminuria**

| Variable | Adjusted OR | 95% CI | p-value |
|---|---|---|---|
| Male | 1.05 | 0.87 – 1.27 | 0.585 |
| Low income | 1.32 | 1.06 – 1.64 | 0.013 |
| Non-Hispanic Black | 1.45 | 0.95 – 2.21 | 0.085 |
| Non-Hispanic White | 0.76 | 0.52 – 1.11 | 0.158 |
| Other Hispanic | 0.97 | 0.62 – 1.52 | 0.886 |
| Other Race | 1.15 | 0.75 – 1.77 | 0.531 |
| Age (per year) | 1.04 | 1.03 – 1.04 | <0.001 |
| Serum creatinine | 1.57 | 1.27 – 1.94 | <0.001 |
| Uric acid | 1.06 | 1.00 – 1.13 | 0.067 |

## 4. Discussion

The results indicate that albuminuria is common among adults and demonstrates clear patterns across biological and socioeconomic factors. The prevalence rates also show that a significant percentage of adults have already reached the initial signs of kidney damage, which supports the significance of albuminuria as a health measure on a population level. The close connection to age indicates that the accumulated exposure to metabolic and vascular stress plays a central role in kidney malfunction. The fact that the albuminuria rate is rising with age is a pointer that the degradation of renal reserve and glomerular susceptibility to age is progressive. The biological plausibility of the findings is also supported by the independent relationship between serum creatinine and albuminuria because the two markers measure different yet related factors of kidney functioning. The uric acid, although with a borderline relationship, has a directional influence, meaning that it may have a contributory influence on impaired renal. It is noteworthy that socioeconomic status was determined to be a determinant, and individuals with lower incomes had higher odds of albuminuria even after the adjustment. It means that it is not only clinical factors that affect the health of the kidneys, but also social conditions in general. Crude differences were also found between sex and race/ethnicity, but were not significant in adjusted analysis. The uric acid, although with a borderline relationship, has a directional influence, meaning that it may have a contributory influence on impaired renal. It is important to note that socioeconomic status was identified as a determinant, and individuals with low incomes were more prone to albuminuria even after adjustment. Determinants and prevalence rates found in this study are in line with the existing evidence that shows that albuminuria is common among adult populations and is strongly correlated with negative outcomes. Previous studies have demonstrated that albuminuria is a risk factor related to the risk of death in various demographic and clinical populations, which is why it is a prognostic factor (Drexler et al., 2023). Likewise, low concentrations of albuminuria have been associated with high risks of mortality, which is why the interpretation of the results is that albuminuria can be considered as an early indicator of pathophysiological changes, but not advanced disease per se (Claudel et al., 2024). The observed age-related trend is consistent with the results of population-based research, which indicate that the prevalence of kidney dysfunction increases with age (Olanrewaju et al., 2020). The studies conducted in particular groups of the population, such as metabolic disorders, also testify to the relevance of disturbed renal physiology and glomerular dynamics in the emergence of early kidney abnormalities (Tricò et al., 2024). Moreover, studies in various population contexts have shown that kidney disease is the result of clinical and contextual factors, and its prevalence is even higher in socially and economically disadvantaged

groups (Gomes et al., 2024). The socioeconomic disadvantage and albuminuria relationship is in line with other studies that reported that poor renal functioning is more prevalent among persons with a lack of access to healthcare and preventive services (Fiseha et al., 2021). Moreover, albuminuria has recently become a risk factor of cardiovascular disease that is not well understood and thus deserves attention in more comprehensive health evaluation (Barzilay et al., 2024). The previous studies have also pointed out differences in the prevalence of albuminuria between racial and ethnic groups, though these patterns are often affected by the differences in testing practices, healthcare access, and underlying risk profiles (Lee et al., 2019). Collectively, these comparisons contribute to the validity of the presented findings and place them in an increasing body of evidence highlighting the clinical and population health significance of albuminuria.The health-related outcomes of the findings and the impact on clinical practice and the health of the population are massive. The incidence of albuminuria is extremely high, and the necessity to introduce early intervention measures to enable the identification of persons at risk before the advanced kidney disease occurs is worth mentioning. Being a factor that is closely linked to age, the elderly population should be screened first, and risk-related interventions should be implemented in the youth and vulnerable groups. The socioeconomic differences in this study indicate that social determinants of health have to be taken care of. The economic barriers, prevention improvement service and increased access to healthcare must be alleviated to lessen the contraction of the kidney disease. Scheduled primary care examination of albuminuria might also contribute to the early diagnosis and treatment. The clinical view of the correlation with serum creatinine warrants the use of different indicators to assess the health of the kidneys. The integration of the sociodemographic factors with biochemical markers may contribute to the strengthening of prevention and management measures and risk-stratification. These findings have several limitations that should be considered during their interpretation. The cross-sectional design restricts the possibility to determine the cause-and-effect relationships of albuminuria and related variables. Misclassification might be brought about by the use of one measurement of albuminuria because of transient elevations that might be caused by acute conditions or variability in measuring albumin. In addition, the study was done on a complete-case basis, which might have created selection bias if the non-reported data were not random. Other clinical variables, including specifics on comorbid conditions, drug use, and lifestyle, that can affect kidney health were also omitted in the study. It is not possible to exclude residual confounding, especially when it comes to the complex interactions of biological and social determinants. Further studies should be designed longitudinally to investigate the development of albuminuria and how it develops into an overt kidney disease. This would be enhanced by the repeated measurements since the classification would be made better, and also the persistence and progression would be measured in a more precise manner. Other areas of future research also involve the mechanisms of socioeconomic disparities, such as access to care, exposure to the environment and health behaviors. It will be important to sample other population regions and use a wider scope of determinants in the development of targeted and fair interventions to decrease the kidney disease burden.

## 5. Conclusion

Albuminuria remains an important population-based indicator of early renal harm and the underlying health disparities. The results prove that it does not influence only adults, but also puts a tremendous burden on older individuals, people with lower income and on individuals with poor biochemical parameters. Age and serum creatinine were found to be the most powerful independent correlates, although the fact that the income gradient is still present after correction proves the impact of socioeconomic factors on the well-being of the kidney. These findings propose the necessity to control albuminuria as a clinical syndrome and a social health problem that needs to be identified and prevented more fairly. The screening and risk assessment models can be improved by paying more attention to the socially disadvantaged groups and traditional clinical predictors. Implementation of albuminuria measurement as a normal practice may aid in identifying the potential patients at earlier stages and raise the chances of

successful treatment of the disease at its earlier stages, before it attains a more critical stage. Both clinical and community health responses will be required to address biological threats and societal conditions that affect kidney health to lessen the burden of albuminuria.

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