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STUDY OF MICROALBUMINURIA AS A CARDIOMETABOLIC RISK FACTOR IN TYPE 2 DIABETES MELLITUS: A CROSS-SECTIONAL STUDY.

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Abstract

Background

The rising occurrence of type 2 diabetes mellitus (T2DM) presents considerable health hazards, particularly concerning heart-related complications. The presence of microalbuminuria acts as an important indicator for the early identification of vascular injury and cardiometabolic risks in individuals with T2DM, emphasizing the necessity for regular screening.

Aims

This work aims to assess the prevalence of microalbuminuria in individuals with type 2 diabetes mellitus in patients residing in Odisha.

Methods

This cross-sectional study took place for over 2.5 years at MKCG Medical College and Hospital, involving 110 patients diagnosed with T2DM. Participants were recruited from the outpatient and inpatient departments of General Medicine and Endocrinology, after obtaining informed consent. Comprehensive demographic and clinical data were collected, alongside laboratory assessments for microalbuminuria using an immunoassay method.

Results

The study comprised 65 males and 45 females, with an average age of 57.07 years. Microalbuminuria was found in 24 of 27 patients (88.89%) with diabetes for 11 years or more ($p < 0.05$). Additionally, 25 of 41 patients (61%) with elevated HbA1C levels had microalbuminuria. Mean fasting blood sugar was significantly higher in the microalbuminuria group (142.83 ± 37.32 mg/dL vs. 127.85 ± 31.36 mg/dL).

Conclusion

Microalbuminuria is significantly associated with the duration of diabetes, poor glycemic control, dyslipidemia, and renal dysfunction in patients with type 2 diabetes mellitus.

Recommendation:

Microalbuminuria is a marker of vascular disease and can be used to support further therapy directed at this complication. For the stated reasons, microalbuminuria testing is recommended.

Keywords: *Type 2 Diabetes Mellitus, Microalbuminuria, Glucose Levels, Cardiovascular Complications.*
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Introduction

Diabetes mellitus has become a major worldwide health issue, defined by increased blood sugar levels due to insulin resistance or insufficient insulin production [1,2]. According to the World Health Organization, the adult population with diabetes globally has surged from 108 million in 1980 to 422 million in 2014, with forecasts indicating a continued rise [3]. In India, the incidence of diabetes has escalated dramatically, with estimates suggesting that more than 77 million individuals were affected as of 2019 [4]. This alarming trend is accompanied by a range of complications, including cardiovascular diseases, kidney dysfunction, and diabetic neuropathy, which collectively impose a substantial burden on healthcare systems.

Microalbuminuria (MA) has been recognized as a significant cardiometabolic risk factor among the complications of type 2 diabetes mellitus (T2DM). It is defined by the presence of trace amounts of albumin in urine, which serves as an early warning sign of kidney damage and correlates with increased cardiovascular morbidity and mortality [5,6]. Research indicates that detecting microalbuminuria in T2DM patients is associated with the progression of vascular disease, making it a crucial marker for evaluating risk [5-8]. Early identification of microalbuminuria can prompt timely

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interventions aimed at mitigating cardiovascular risks, ultimately improving patient outcomes.

In the state of Odisha, the incidence of diabetes is notably rising, paralleling national trends. The region has witnessed a growing number of cases of diabetic cardiomyopathy, where patients often present with dyspnea indicative of congestive heart failure but without typical angina symptoms [9]. Despite the significance of early detection, routine evaluations for microalbuminuria remain scarce in low-resource settings, including our healthcare center. This lack of regular screening limits opportunities for proactive management of cardiovascular risks among individuals with diabetes, emphasizing the need for a concerted effort to address this gap in care [10,11].

Given this context, our study intends to examine the incidence of microalbuminuria in individuals with T2DM in Odisha as well as explore its potential as a predictive marker for cardiovascular involvement. By focusing on the relationship between microalbuminuria and cardiometabolic risks, we hope to implement measures that may delay it from transitioning to end-stage renal disease (ESRD) and reduce cardiovascular morbidity. Ultimately, our research seeks to inform clinical practice guidelines for managing patients with T2DM, highlighting the importance of routine screening for microalbuminuria in diabetes care in Odisha.

Aim of the study

The present study intends to examine the prevalence of microalbuminuria among individuals with T2DM at MKCG Medical College and Hospital, Berhampur, Odisha.

Methods

Study Design

This cross-sectional study was carried out over 2.5 years at MKCG Medical College and Hospital in Berhampur, focusing on patients with T2DM. The design allowed for the assessment of microalbuminuria prevalence and its connection with cardiovascular predisposing factors in a specific patient population. Patients without established T2DM but presenting clinical symptoms were subjected to an oral glucose tolerance test and fasting blood glucose concentration. All the participants observed fasting overnight for 8 hours and avoiding unnecessary exercise throughout the tests spanning 2 hours.

Study Setting

The study was carried out at the Department of Pathology in collaboration with the Department of General Medicine and Department of Endocrinology, MKCG Medical College and Hospital, Berhampur.

Study Population

The study cohort encompassed 110 patients with a clinical diagnosis of T2DM and attending (or) admitted to the medicine and Endocrinology OPD.

Inclusion Criteria

The study included participants who were 18 years of age or older. Individuals diagnosed with type 2 diabetes mellitus according to the American Diabetes Association criteria (2000) were eligible for inclusion. Those exhibiting diabetes symptoms alongside a random glucose level of 200 mg/dl or higher, a fasting blood glucose level of 126 mg/dl or greater, an HbA1C level exceeding 6.5%, or a two-hour plasma glucose level of 200 mg/dl or more during an oral glucose tolerance test were considered for this study. Only patients willing to provide informed consent were considered for the study. Those attending the outpatient department (OPD) of General Medicine and Endocrinology or admitted to the ward at MKCG Medical College and Hospital were included.

Exclusion Criteria

Individuals with high blood pressure, ischemic heart disease, valvular heart conditions, chronic kidney disease, urinary tract infections, proteinuria, and severe anemia were not included in the study.

Data Collection

Eligible patients were selected from the outpatient Departments of General Medicine and Endocrinology, as well as from inpatient wards at MKCG Medical College and Hospital. After obtaining informed consent, each participant's demographic and clinical data such as hemoglobin (gm%), differential count, total leucocyte count, BMI, plasma glucose level (RA-50 BAYER diagnostic), lipid profile, and HbA1C levels, were collected. This systematic approach ensured that relevant information was consistently gathered, facilitating a comprehensive analysis of the patient cohort. To carry out the tests, a fasting blood glucose estimation was collected, following which the patients were allowed to drink 75 g of glucose in 300 ml of water. The next sample was collected after 2 hours and the plasma glucose values obtained by glucose oxidase methods were interpreted.

Laboratory Assessment

Urine samples were collected from participants to measure microalbuminuria levels, utilizing an immunoassay method for testing. COMBINA 13 urine test strips were dipped into the fresh, well-mixed uncentrifuged urine specimen for up to 1 second. Excess urine was wiped off and the strip was placed on a strip holder in the collect slot of the urine analyzer. After automatically testing in the optical systems, the baseline values were recorded. Similar observations were noted twice between regular intervals during the 180-day study period to detect the presence of elevated albumin levels for the diagnosis of MAU in the patients.

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Statistical Analysis

Statistical analysis included the calculation of frequencies and percentages for categorical variables, as well as means and standard deviations (SD) for continuous variables. Chi-square tests assessed associations between microalbuminuria and factors like duration of diabetes, HbA1C levels, BMI, and renal function, with a p-value < 0.05 considered significant. T-tests compared mean laboratory parameters between groups with and without microalbuminuria.

Results

The study cohort comprised 110 patients with T2DM, of which 65 were male and 45 were female. The average age was comparable between genders, with males having a mean age of 56.93 years and females 57.53 years, leading to an overall average age of 57.07 years. Regarding the duration of diabetes, 46 patients (41.82%) had diabetes for less than 5 years, 41 patients (37.27%) had diabetes for 6-10 years, and 23 patients (20.91%) had been living with diabetes for 11 years or more (Table 1).

Table 1: Demographic characteristics of the study cohort

	Male	Female	Total
Total patient count	65	45	110
Mean age	56.93	57.53	57.07
Duration of DM			
< 5	27 (41.53%)	19 (42.22%)	46
6-10	23 (35.93%)	18 (40%)	41
≥11	15 (23.07%)	8 (17.77%)	23

The occurrence of microalbuminuria was significantly linked to various factors, including the duration of diabetes, HbA1C levels, body mass index (BMI), lipid profiles, and kidney function. Notably, microalbuminuria was more prevalent among patients with a longer history of diabetes, with 24 out of 27 individuals having diabetes for 11 years or more testing positive ($p < 0.05$). Additionally, higher HbA1C levels (exceeding 8%) were correlated with an increased incidence of microalbuminuria, as 25 of the 41 patients in this category exhibited this condition ($p = 0.005$). Furthermore, patients with a BMI of 25 kg/m² or more were found to have a greater likelihood of microalbuminuria ($p = 0.032$). Dyslipidemia was also significantly associated with microalbuminuria, particularly concerning elevated total cholesterol levels (over 200 mg%) and reduced HDL cholesterol levels (below 40 mg%), with p-values of 0.025 and 0.0012, respectively. Additionally, creatinine levels exceeding 1.2 mg% and urea levels over 40 mg% were significantly associated with microalbuminuria ($p = 0.003$ and $p = 0.021$), highlighting the influence of kidney function on this condition (Table 2).

Table 2: Correlation of Various Factors with the Occurrence of Microalbuminuria

	Microalbuminuria			p-value
	Positive	Negative	Total	
Duration of DM				
< 5	7	51	58	-
6-10	16	9	25	-
≥11	24	3	27	-
HbA1C				
< 6.5	5	8	13	0.005
6.5-8	17	39	56	
>8	25	16	41	
BMI (kg/m²)				
>18	0	6	5	0.032
18-22.9	7	37	42	
23-24.9	19	16	34	
≥25	21	8	29	
Lipid profile				
Total cholesterol > 200 mg%	20	10	30	0.025
Triglyceride> 150 mg%	35	32	67	0.0174
LDL Cholesterol > 100 mg%	27	17	52	0.177

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HDL Cholesterol < 40 mg%	21	10	31	0.0012
Renal function				
Creatinine > 1.2 mg%	23	14	37	0.003
Urea > 40 mg%	10	4	14	0.021
Uric acid > 0.6 mg%	6	8	14	1.0
Complications of diabetes				
Retinopathy	12	5	17	0.0145
Ischemic heart disease	7	2	9	0.030
Peripheral vascular disease	3	2	5	0.64
Peripheral neuropathy	8	5	13	0.14

Patients exhibiting microalbuminuria demonstrated significantly elevated mean fasting blood glucose (FBS) and postprandial blood glucose (PPBS) levels compared to those without the condition, with p-values of 0.024 and 0.021, respectively. Additionally, the microalbuminuria group had higher mean total cholesterol and LDL cholesterol levels, showing p-values of 0.037 and 0.027, respectively. Importantly, these patients also presented significantly reduced HDL cholesterol levels (p = 0.001) and increased creatinine levels (p = 0.02), indicating poorer lipid and renal profiles. While blood urea levels were also greater in the microalbuminuria group (p = 0.0125), no significant difference was noted for uric acid levels. These results imply that microalbuminuria is linked to deteriorating glycemic control, lipid imbalances, and renal impairment in individuals with diabetes (Table 3).

Table 3: Mean lab parameters in the presence of microalbuminuria

	Microalbuminuria (Mean±SD)		**Significance by student t-test**
Lab parameters	**Absent**	**Present**	
FBS	127.85 ± 31.36	142.83 ± 37.32	0.024
PPBS	185.2 ± 54.08	210.34 ± 57.83	0.021
Total cholesterol	176.2 ± 25.01	190.5 ± 43.18	0.037
Triglyceride	176.65 ± 41.33	188.63 ± 37.53	0.12
LDL	96.01 ± 28.07	111.23 ± 43.17	0.027
HDL	44.85 ± 6.16	41 ± 6.11	0.001
Blood urea	31.24 ± 6.28	34.61 ± 7.61	0.0125
Creatinine	1.17 ± 0.419	1.34 ± 0.323	0.02
Uric acid	4.77 ± 1.05	5.09 ± 1.07	0.12

Discussion

This study assessed the incidence of microalbuminuria in patients with T2DM as well as its association with various cardiometabolic risk factors. Our findings demonstrated that microalbuminuria was positively associated with longer diabetes duration, poorer glycemic control, increased body mass index (BMI), dyslipidemia, and impaired renal function. Specifically, among the 110 patients studied, 47.27% exhibited microalbuminuria, highlighting its prevalence in this population. These results are consistent with previous research, such as that by Chowta et al. (2009) and Sigdel et al. (2008), which showed a prevalence of 45.5% and 37%, respectively, reinforcing microalbuminuria as a marker of diabetic complications, particularly in predicting cardiovascular and renal risks.

Our study demonstrated that those having diabetes for longer periods had a significantly higher prevalence of microalbuminuria. For instance, 24 out of 27 patients (88.89%) with diabetes for more than 11 years exhibited microalbuminuria, compared to only 12.07% (7 out of 58) in those with diabetes for less than 5 years. This aligns with findings from studies by Raman et al. (1996) and Sigdel et al. (2008) which showed a mean age of 15.5 years and 11.3 years in their respective studies, thereby establishing a strong association between prolonged diabetes duration and the development of microalbuminuria, likely due to cumulative glycemic burden leading to microvascular damage. Early detection of microalbuminuria in these patients is crucial for preventing transition to macroalbuminuria and eventual ESRD.

In this study, patients with poorly managed diabetes (HbA1C > 8%) had a significantly higher prevalence of microalbuminuria, with 25 out of 41 patients (60.98%) showing positive results compared to only 38.46% (5 out of 13) in those with HbA1C < 6.5%. Previous studies, such as those by Ravid et al. (1998) and Phadnis et al. (2017), have similarly revealed a connection between the prevalence of microalbuminuria and fasting blood sugar levels and HbA1c levels. The study by Afkahami-Ardekani et al (2008), however, contrasted this by showing no statistically significant correlation between these variables.

Our study also found that microalbuminuria was more prevalent in patients with higher BMI, particularly those with a BMI ≥25 kg/m², where 21 out of 29 patients (72.41%) exhibited microalbuminuria. This finding is supported by previous research, such as the study by Lamba et al., which showed a strong relationship between obesity with microalbuminuria (BMI of 24 in microalbuminuria vs BMI of 23.71 in normoalbuminuria). Increased BMI is associated with insulin resistance and hyperfiltration, both of which contribute to albumin leakage in the urine. These findings emphasize the need for weight management strategies to mitigate renal and cardiovascular risks in overweight or obese diabetic patients.

Dyslipidemia, particularly elevated total cholesterol, and low HDL cholesterol levels, was significantly associated with microalbuminuria in our cohort. Specifically, 20 out of 30 patients (66.67%) with total cholesterol > 200 mg% had microalbuminuria. This is in line with studies by Lamba et al. and Dadhania et al. (2012), who identified dyslipidemia as a key predisposing factor for both cardiovascular disease as well as diabetic nephropathy. Dyslipidemia exacerbates endothelial dysfunction and promotes glomerular damage, increasing the likelihood of albuminuria. Thus, lipid management should be a priority in the care of diabetic patients with microalbuminuria.

In our study, patients with elevated serum creatinine (> 1.2 mg%) showed a high prevalence of microalbuminuria, with 23 out of 37 patients (62.16%) testing positive. This aligns with previous studies, such as those by Dadhania et al. (2012) and Ghosh et al. (2013), who have shown that declining renal function is linked with the presence of microalbuminuria in diabetic patients, often serving as a precursor to overt nephropathy. Early intervention in patients with microalbuminuria may help delay progression to ESRD and reduce cardiovascular mortality.

We also observed a significant association between microalbuminuria and cardiovascular complications, with 12 out of 17 patients (70.59%) with retinopathy and 7 out of 9 patients (77.78%) with ischemic heart disease exhibiting microalbuminuria. This aligns with research by Gerstein et al. (2001) and Ingelsson et al. (2007), demonstrating a significant correlation of microalbuminuria with cardiovascular morbidity in patients with T2DM. Given its role as an early marker of systemic vascular damage, routine screening for microalbuminuria in diabetic patients could help identify those at higher risk for cardiovascular events, allowing for timely intervention.

Conclusion

This study emphasizes the significant incidence rates of microalbuminuria among T2DM patients, with 47.27% of participants affected. The findings demonstrate a strong association between microalbuminuria and several cardiometabolic risk factors, including prolonged diabetes duration, poor glycemic control, elevated BMI, dyslipidemia, and impaired renal function. These results highlight the importance of early diagnosis and monitoring of microalbuminuria in diabetic patients, as it is a crucial indicator of kidney and cardiovascular health. Implementing routine screening for microalbuminuria could facilitate timely interventions, potentially reducing the risk of macroalbuminuria, chronic kidney disease, and associated cardiovascular complications. Overall, our study emphasizes the need for comprehensive management strategies targeting not only blood glucose levels but also associated risk factors to improve patient outcomes in the diabetic population.

Recommendation: Microalbuminuria is a marker of vascular disease and can be used to support further therapy directed at this complication. For the stated reasons, microalbuminuria testing is recommended.

Limitations: The study is limited by its short duration and small sample size.

Acknowledgment

To all the participants for their cooperation and patience.

List of Abbreviations

T2DM- Type 2 diabetes mellitus
HbA1C- Glycated Haemoglobin
MA/MAU- Microalbuminuria
OPD- Outpatient Department
BMI- Body Mass Index
SD- standard deviations
HDL- high-density lipoprotein
LDL- low-density lipoprotein
FBS- fasting blood glucose
PPBS- postprandial blood glucose
ESRD- End-Stage Renal Disease

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No conflict of interest

References

1. Galicia-Garcia, U., Benito-Vicente, A., Jebari, S., Larrea-Sebal, A., Siddiqi, H., Uribe, K. B., Ostolaza, H., & Martín, C. (2020). Pathophysiology of Type 2 Diabetes

Mellitus. *International journal of molecular sciences*, *21*(17), 6275. https://doi.org/10.3390/ijms21176275

2. Banday, M. Z., Sameer, A. S., & Nissar, S. (2020). Pathophysiology of diabetes: An overview. *Avicenna journal of medicine*, *10*(4), 174–188. https://doi.org/10.4103/ajm.ajm_53_20
3. World Health Organization. (2023, April 5). Diabetes. World Health Organisation; WHO. https://www.who.int/news-room/fact-sheets/detail/diabetes
4. Pradeepa, R., & Mohan, V. (2021). Epidemiology of type 2 diabetes in India. Indian journal of ophthalmology, 69(11), 2932–2938. https://doi.org/10.4103/ijo.IJO_1627_21
5. Asghar, S., Asghar, S., Mahmood, T., Bukhari, S. M. H., Mumtaz, M. H., & Rasheed, A. (2023). Microalbuminuria as the Tip of Iceberg in Type 2 Diabetes Mellitus: Prevalence, Risk Factors, and Associated Diabetic Complications. Cureus, 15(8), e43190. https://doi.org/10.7759/cureus.43190
6. Bae, E. S., Hur, J. Y., Jang, H. S., Kim, J. S., & Kang, H. S. (2023). Risk Factors of Microalbuminuria among Patients with Type 2 Diabetes Mellitus in Korea: A Cross-Sectional Study Based on 2019-2020 Korea National Health and Nutrition Examination Survey Data. International journal of environmental research and public health, 20(5), 4169. https://doi.org/10.3390/ijerph20054169
7. Yang C.W., Park J.T., Kim Y.S., Kim Y.L., Lee Y.S., Oh Y.S., Kang S.W. Prevalence of diabetic nephropathy in primary care type 2 diabetic patients with hypertension: Data from the Korean Epidemiology Study on Hypertension III (KEY III study) Nephrol. Dial. Transplant. 2011; 26:3249–3255. doi: 10.1093/ndt/gfr011.
8. Sukhram S.D., Zarini G.G., Shaban L.H., Vaccaro J.A., Huffman F.G. Microalbuminuria and hypertension among immigrants with type 2 diabetes: A community-based cross-sectional study. *J. Pers. Med.* 2022; **12:1777**. Doi: 10.3390/jpm12111777.
9. Pradhan, P., Sanjeev Supakar, Nayak, S., Lipika Behera, & Jaya Kshatri. (2022). Prevalence of diabetes in Odisha, India: A systematic review and meta-analysis. Journal of Diabetology, 13(3), 227–227. https://doi.org/10.4103/jod.jod_53_22
10. Jyotsna, F., Ahmed, A., Kumar, K., Kaur, P., Chaudhary, M. H., Kumar, S., Khan, E., Khanam, B., Shah, S. U., Varrassi, G., Khatri, M., Kumar, S., & Kakadiya, K. A. (2023). Exploring the Complex Connection Between Diabetes and Cardiovascular Disease: Analyzing Approaches to Mitigate Cardiovascular Risk in Patients With Diabetes. Cureus, 15(8), e43882. https://doi.org/10.7759/cureus.43882
11. Ghimire B, Sakiewicz AJ. Management of Cardiovascular and Diabetes Risks Based on National Guidelines. In: StatPearls. Treasure Island (FL): StatPearls Publishing; 2024 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK580534/
12. Chowta, N. K., Pant, P., & Chowta, M. N. (2009). Microalbuminuria in diabetes mellitus: Association with age, sex, weight, and creatinine clearance. *Indian journal of nephrology*, *19*(2), 53–56. https://doi.org/10.4103/0971-4065.53322
13. Sigdel, M., Rajbhandari, N., Basnet, S., Nagila, A., Basnet, P., & Tamrakar, B. K. (2008). Microalbuminuria among type-2 diabetes mellitus patients in Pokhara, Nepal. *Nepal Medical College journal: NMCJ*, *10*(4), 242–245.
14. Raman P.G., Hussain R, Taisankar K. Prevalence of microalbuminuria in diabetes mellitus and its correlation with various complications. J.Dial. Asso. India. 1996; 36 (3): 77-80.
15. Ravid, M., Brosh, D., Ravid-Safran, D., Levy, Z., & Rachmani, R. (1998). The main risk factors for nephropathy in type 2 diabetes mellitus are plasma cholesterol levels, mean blood pressure, and hyperglycemia. Archives of internal medicine, 158(9), 998–1004. https://doi.org/10.1001/archinte.158.9.998
16. Phadnis, P., Kamble, M. A., Daigavane, S., Tidke, P., & Gautam, S. (2017). Prevalence and risk factors–Hemoglobin A1c, serum magnesium, lipids, and microalbuminuria for diabetic retinopathy: A rural Hospital-based study. Journal of Datta Meghe Institute of Medical Sciences University, 12(2), 121-132.
17. Lamba IMS, Sircar S, Taneja V, Kansra UU. Microalbuminuria in normotensive non-insulin-dependent diabetic subjects – Association and prediction. J. Diab. Assoc. 1997; 37(2):32-36.
18. Dadhania, B. P., Aravat, A. H., & Dhruva, G. A. (2012). Study of microalbuminuria in Diabetes Type 2 patients as a marker of morbidity (A study of 100 cases in Rajkot city). International Journal of Biomedical and Advance Research, 3(10). https://doi.org/10.7439/ijbar.v3i10.769
19. Ghosh, S., Lyaruu, I., & Yeates, K. (2012). Prevalence and factors associated with microalbuminuria in type 2 diabetic patients at a diabetes clinic in northern Tanzania. *African Journal of Diabetes Medicine*, *20*(2).
20. Gerstein, H. C., Mann, J. F., Yi, Q., Zinman, B., Dinneen, S. F., Hoogwerf, B., Hallé, J. P.,

Young, J., Rashkow, A., Joyce, C., Nawaz, S., Yusuf, S., & HOPE Study Investigators (2001). Albuminuria and risk of cardiovascular events, death, and heart failure in diabetic and nondiabetic individuals. JAMA, 286(4), 421–426. https://doi.org/10.1001/jama.286.4.421

21. Ingelsson, E., Sundström, J., Lind, L., Risérus, U., Larsson, A., Basu, S., & Arnlöv, J. (2007). Low-grade albuminuria and the incidence of heart failure in a community-based cohort of elderly men. *European Heart Journal*, *28*(14), 1739–1745. https://doi.org/10.1093/eurheartj/ehm130

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