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Public Health Implications of Serum Albumin and Globulin Changes in Relation to Lifestyle and Physical Activity in Non-Viral Hepatocellular Injury.

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ABSTRACT
Non-viral hepatocellular injury is a significant contributor to impaired liver function, with serum albumin and globulin serving as sensitive indicators of hepatic synthetic capacity. This retrospective cross-sectional study examined the influence of lifestyle factors and physical activity on serum protein profiles in a rural Nigerian population. A total of 100 adults with abnormal liver enzyme profiles but negative viral serology were included. Serum albumin and total protein were measured using the bromocresol green and Biuret methods, respectively, and globulin was calculated as the difference between total protein and albumin. Lifestyle assessment revealed that 38% of participants consumed alcohol habitually, 42% used herbal preparations, and only 27% engaged in regular physical activity. Hypoalbuminemia (<3.5 g/dL) was observed in 77% of participants, while elevated globulin (>3.5 g/dL) occurred in 69%. Herbal toxicity (20%), alcoholic hepatitis (20%), and drug-induced liver injury (15%) were the predominant etiologies. Lower albumin and higher globulin levels were significantly associated with chronic hepatic stress markers ($p < 0.05$). Notably, participants reporting regular physical activity exhibited relatively preserved albumin levels and lower globulin concentrations, suggesting a potential modulatory effect on hepatic protein synthesis. These findings highlight the interplay between lifestyle behaviors, physical activity, and liver health, emphasising the need for public health interventions that promote healthy behaviors to mitigate hepatic synthetic dysfunction in populations at risk.

Keywords: Non-viral hepatocellular injury, Serum albumin, Serum globulin, Hepatic synthetic dysfunction, Physical activity, Physiotherapy, Lifestyle factors

1. INTRODUCTION

Liver diseases remain a significant global health concern, contributing to substantial morbidity and mortality worldwide (Ibezim *et al.*, 2025). While viral hepatitis is a leading cause, non-viral hepatocellular injury—including alcohol-induced liver damage, drug-induced liver injury, and herbal toxicity—constitutes a growing burden, particularly in low-resource settings (Lozano *et al.*, 2012; Smith & Adams, 2018). The liver is the primary site of protein synthesis, and serum albumin and globulin are among the most sensitive markers of hepatic synthetic capacity. Albumin declines early in chronic hepatocellular dysfunction due to impaired synthesis, while globulin levels often rise as a result of persistent inflammation, immune activation, or chronic hepatic injury (Giannini *et al.*, 2003; Gatta *et al.*, 2004). These proteins were selected as the focus of this study because they are low-cost, widely available laboratory parameters that offer valuable insights into synthetic impairment, making them particularly relevant for resource-limited rural settings where advanced diagnostic tools may not be accessible.

Despite their clinical importance, few studies in rural Nigerian populations have assessed albumin and globulin alterations in non-viral liver injury, even though exposure to unregulated herbal remedies, alcohol, and hepatotoxic medications is common (Ogunleye *et al.*, 2020). Beyond biochemical parameters, lifestyle components such as physical activity may influence liver health by modulating metabolic, vascular, and inflammatory pathways. Regular physical activity has been shown to reduce hepatic fat accumulation, improve insulin sensitivity, attenuate systemic inflammation, and potentially stabilise serum protein profiles through enhanced hepatic perfusion and metabolic regulation (Sofi *et al.*, 2011). Integrating physiotherapeutic perspectives therefore provides a theoretical framework for understanding how lifestyle behaviours may modify hepatic synthetic function, particularly in communities where sedentary lifestyles coexist with hepatotoxic exposures.

This study aimed to characterize serum albumin and globulin patterns, evaluate the extent of hepatic synthetic impairment, examine the potential modulatory influence of physical activity, and investigate the relationship between serum protein alterations and lifestyle factors in a rural Nigerian population, with implications for liver health promotion and public health interventions.

2. METHODS

2.1 Study Design

This research employed a retrospective cross-sectional design and was carried out at Igbinedion University Teaching Hospital (IUTH), Okada, Edo State, Nigeria, over the period from January 2023 to March 2025. This timeframe was selected because complete laboratory and clinical records for adults with non-viral liver dysfunction were available for this interval, and a two-year window ensured adequate case accrual while maintaining consistency in biochemical assay methods and record-keeping practices. The primary objective was to evaluate alterations in liver enzyme levels among adults presenting with non-viral liver dysfunction.

2.1.1 Study Population

The study included 100 adult patients (aged 18 years and above) who exhibited abnormal liver enzyme profiles but tested negative for hepatitis viruses A, B, C, D, and E. Only individuals with complete clinical and laboratory records relevant to liver function assessment were considered for inclusion.

2.1.2 Sample Size Determination

The minimum sample size for the study was calculated using the Cochran (1977) formula, which is suitable for cross-sectional research designs.

$n = Z^2 \times p(1-p) / d^2$

- n = desired sample size
- Z = 1.96 (standard normal deviation for 95% confidence level)
- p = estimated prevalence of non-viral liver dysfunction (assumed at 0.5 for maximum variability)
- d = margin of error (0.1)

Substituting these values:

$n = (1.96^2 \times 0.5\ (1 - 0.5)) / 0.1^2$

$n = (3.8416 \times 0.25) / 0.01$

$n = 0.9604 / 0.01$

$n = 96.04$

To compensate for incomplete data and possible exclusions, the sample size was adjusted to 100 participants.

2.1.3 Inclusion Criteria

- Adults aged 18 years and above attending Igbinedion University Teaching Hospital (IUTH), Okada, Edo State, Nigeria.
- Patients with documented abnormal liver enzyme profiles (elevated AST, ALT, ALP, or GGT).

- Negative viral serology for hepatitis A, B, C, D, and E.
- Availability of complete clinical records, including demographic, lifestyle, and laboratory data relevant to liver function.
- Consent for retrospective use of clinical and laboratory data, in line with ethical approval.
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2.1.4 Exclusion Criteria

- Patients with confirmed viral hepatitis infection.
- Individuals with incomplete or missing laboratory records for liver function tests.
- Patients with concurrent chronic illnesses known to affect serum protein levels (e.g., nephrotic syndrome, chronic kidney disease, severe malnutrition).
- Pregnant women, due to physiological alterations in serum protein levels.
- Patients on chronic immunosuppressive therapy or corticosteroids, which may alter albumin and globulin levels.

2.2 Data and Sample Collection

Patient demographic details, clinical presentations, potential risk factors (such as alcohol intake and medication history), and final diagnoses were extracted from hospital records using a standardised data collection form. The hospital records used for this study follow a uniform documentation structure, with routine updates entered into the electronic medical record and laboratory reporting system. Only files with complete and consistently recorded clinical and laboratory information were eligible for inclusion to ensure data accuracy and comparability.

For analytical purposes, diagnoses were organised into clinically relevant categories, including alcoholic hepatitis, drug-induced liver injury (DILI), autoimmune hepatitis, aflatoxin-associated liver damage, parasitic infections, protein-energy malnutrition, and herbal toxicity. Diagnostic categorisation was initially performed by the attending Medical Officer and subsequently reviewed by a Chief Consultant in collaboration with the Department of Biochemistry to ensure consistency and accuracy.

Blood samples were allowed to clot at room temperature for 30 minutes and then centrifuged at 3,000 rpm for 10 minutes to separate serum. Only serum samples with complete laboratory documentation were included in the analysis. Aliquots were stored at –20°C until biochemical analysis to preserve the stability of albumin and total protein measurements.

2.3 Biochemical Analysis of Albumin and Globulin

2.3.1 Serum Albumin Measurement

Serum albumin was determined using the bromocresol green (BCG) dye-binding method as described by Doumas *et al.* (1971) and standardized in Tietz Textbook of Clinical Chemistry and Molecular Diagnostics (Burtis *et al.*, 2012).. In this method, albumin in the serum reacts with bromocresol green in a buffered solution to form a green-colored complex. The intensity of the color is directly proportional to the albumin concentration and is measured spectrophotometrically at 628 nm. Calibration was performed using standard albumin solutions, and each sample was assayed in duplicate to ensure accuracy. The reference range for serum albumin was 3.5–5.0 g/dL, with values below 3.5 g/dL considered hypoalbuminemic.

2.3.2 Total Protein Measurement

Total serum protein was measured using the Biuret method in accordance with Gornall *et al.* (1949) and Doumas *et al.* (1981). This method relies on the reaction between peptide bonds in proteins and copper ions under alkaline conditions to produce a violet-colored complex. The absorbance of this complex was measured spectrophotometrically at 540 nm. Standard protein solutions were used to generate a calibration curve, and all assays were performed in duplicate.

2.3.3 Serum Globulin Calculation

Serum globulin concentration was calculated indirectly by subtracting the measured serum albumin from the total protein:

Globulin (g/dL) = Total Protein (g/dL) – Albumin (g/dL)

Values above 3.5 g/dL were considered elevated, indicative of hyperglobulinemia. (Reinhold, 1953)

2.3.4 Quality Control Measures

- All reagents and instruments were calibrated according to the manufacturer's instructions.

- Duplicate measurements were performed for all samples, and the mean value was used for statistical analysis.
- Standard reference sera were run with each batch to monitor assay accuracy.
- Samples were processed under controlled laboratory conditions to minimise pre-analytical variability.

2.4 Statistical Analysis

Data obtained from the study were entered into the Statistical Package for the Social Sciences (SPSS) software, version 26.0 (IBM Corp., Armonk, NY, USA) for processing and analysis. Prior to statistical evaluation, all data were checked for completeness, consistency, and accuracy. Descriptive statistics were applied to summarise clinical characteristics of participants, with results presented as frequencies, percentages, means, and standard deviations, as appropriate. Associations between categorical variables, such as serum albumin or globulin levels and etiological factors, were examined using the Chi-square (χ^2) test. The strength and direction of associations between continuous variables, including serum proteins and liver enzyme markers, were evaluated using Kendall's tau-b correlation coefficient. A p-value of less than 0.05 was considered statistically significant. Results were presented in tables and charts for clarity and ease of interpretation. All statistical procedures adhered to conventional biostatistical standards for cross-sectional and retrospective analyses.

2.5 Ethical Consideration

Ethical approval for the study was obtained from the Health Research Ethics Committee (HREC) of Igbinedion University Teaching Hospital (IUTH), Okada, Edo State, Nigeria, with protocol number IUTH/R.24/VOL.I/156. All patient data were treated with strict confidentiality, and personal identifiers were excluded before analysis to ensure anonymity. The research was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki for studies involving human participants (World Medical Association, 2013).

3. RESULTS

3.1 Demographic and Clinical Characteristics of Participants

A total of 100 adults with non-viral hepatocellular injury were included in the study. The participants ranged in age from 21 to 68 years, with a mean age of 44.7 ± 12.6 years. There was a slight male predominance, accounting for 54% of the study population. Most participants were residents of rural communities and engaged in subsistence occupations such as farming and trading. Lifestyle assessment revealed that 38% reported habitual alcohol consumption, 42% admitted to the use of herbal preparations, while only 27% engaged in regular physical activity.

3.2 Pattern of Serum Albumin and Globulin Levels

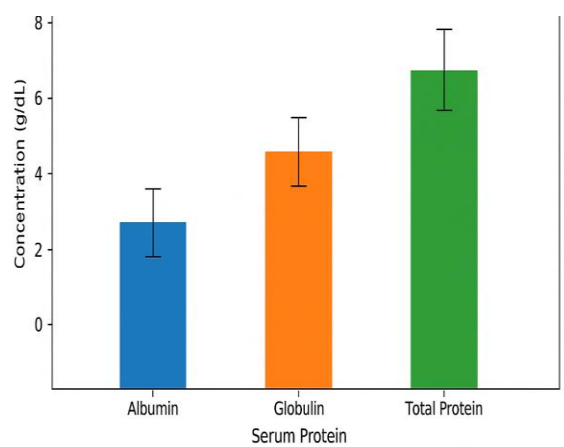

Figure 1: Serum protein Concentrations among Patients with Non-Viral Hepatocellular Injury

Analysis of serum proteins, as seen in Figure 1, revealed marked disturbances in hepatic synthetic function. Hypoalbuminemia (<3.5 g/dL) was observed in 77% of participants, while only 23% maintained normal albumin levels. In contrast, elevated serum globulin (>3.5 g/dL) occurred in 69% of cases, suggesting increased immunoglobulin synthesis or chronic hepatic inflammation. The mean serum albumin concentration was 3.12 ± 0.68 g/dL, while the mean total protein was 7.8 ± 0.9 g/dL. The derived mean globulin value was 4.68 ± 0.78 g/dL.

3.3 Relationship between Serum Proteins and Etiological Factors

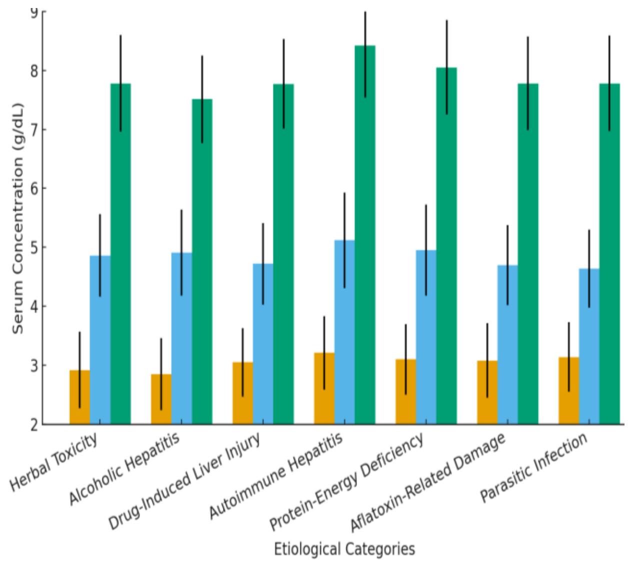

Figure 2: Mean Serum Albumin, Globulin, and Total Protein Levels by Aetiology among Patients with Non-Viral Hepatocellular Injury
(Relationship between low serum albumin and toxic etiologies of hepatocellular injury ($p = 0.002$); Relationship between elevated globulin and toxic etiologies of hepatocellular injury ($p = 0.07$))

When stratified according to aetiology, patients with alcoholic hepatitis and herbal toxicity recorded the lowest mean serum albumin levels of 2.85 ± 0.61 g/dL and 2.92 ± 0.65 g/dL, respectively as shown in Figure 2. These groups also exhibited relatively high mean globulin concentrations of 4.91 ± 0.73 g/dL and 4.86 ± 0.70 g/dL. Participants diagnosed with drug-induced liver injury (DILI) showed moderately reduced albumin levels (3.05 ± 0.58 g/dL) and elevated globulin levels (4.72 ± 0.69 g/dL). In contrast, patients with autoimmune hepatitis and protein-energy deficiency demonstrated significantly higher globulin levels (5.12 ± 0.81 g/dL and 4.95 ± 0.77 g/dL, respectively), consistent with chronic inflammatory or immune-mediated processes. The total serum protein concentrations among all etiological subgroups ranged between 7.5 and 8.4 g/dL, with the highest mean observed in autoimmune hepatitis (8.42 ± 0.88 g/dL) and the lowest in alcoholic hepatitis (7.51 ± 0.74 g/dL). Chi-square analysis demonstrated a statistically significant association between low serum albumin and toxic etiologies of hepatocellular injury ($\chi^2 = 12.46$, $p = 0.002$). However, the relationship between elevated globulin and the type of hepatic injury did not reach statistical significance ($p = 0.07$). These findings suggest that hepatic synthetic impairment, as reflected by albumin depletion, is more pronounced in toxic and metabolic causes of liver injury compared to immune-mediated or nutritional causes.

3.4 Influence of Lifestyle Factors on Serum Protein Profiles

Table 1: Influence of Lifestyle Factors on Serum Albumin and Globulin Levels in Adults with Non-Viral Hepatocellular Injury

Lifestyle Factor	n (%)	Serum Albumin (g/dL)	Serum Globulin (g/dL)
Alcohol consumers	38 (38%)	2.85 ± 0.61	4.12 ± 0.85
Non-alcohol users	62 (62%)	3.42 ± 0.55	3.48 ± 0.60
Herbal medication users	42 (42%)	2.90 ± 0.58	4.05 ± 0.78
Non-herbal users	58 (58%)	3.40 ± 0.52	3.50 ± 0.61
Regular physical activity	27 (27%)	3.35 ± 0.57	3.55 ± 0.63
Sedentary	73 (73%)	2.95 ± 0.62	4.00 ± 0.80

Lifestyle variables, as seen in Table 1, demonstrated notable effects on serum protein alterations among the study participants. Of the 100 adults with non-viral hepatocellular injury, 38% reported habitual alcohol consumption. These individuals exhibited lower mean serum albumin levels (2.85 ± 0.61 g/dL) and higher mean globulin levels (4.12 ± 0.85 g/dL) compared with non-alcohol users (albumin: 3.42 ± 0.55 g/dL; globulin: 3.48 ± 0.60 g/dL, $p < 0.05$). Similarly, 42% of participants admitted to regular use of herbal preparations, which was associated with hypoalbuminemia (2.90 ± 0.58 g/dL) and hyperglobulinemia (4.05 ± 0.78 g/dL) relative to non-herbal users (albumin: 3.40 ± 0.52 g/dL; globulin: 3.50 ± 0.61 g/dL, $p < 0.05$). Engagement in regular physical activity was reported by only 27% of participants. Those who were moderately active demonstrated relatively preserved albumin levels (3.35 ± 0.57 g/dL) and lower globulin concentrations (3.55 ± 0.63 g/dL) compared with sedentary individuals (albumin: 2.95 ± 0.62 g/dL; globulin: 4.00 ± 0.80 g/dL, $p < 0.05$), suggesting a potential modulatory effect of physical activity on hepatic protein synthesis and inflammatory balance.

4. DISCUSSION

4.1 Demographic and Clinical Characteristics of Participants

The high prevalence of alcohol consumption (38%) aligns with findings from Lasebikan (2016), who reported that alcohol use is common in semi-rural Nigerian communities, with most drinkers at moderate or high health risk. Similarly, the use of herbal preparations (42%) is consistent with studies indicating that a significant proportion of Nigerians, particularly in rural areas, utilise herbal medicine as a first-line treatment (Oyeleye *et al*., 2022). The low percentage (27%) of participants engaging in regular physical activity is noteworthy. Although this study's cross-sectional design does not allow causal inference, these demographic and lifestyle characteristics provide context for non-viral hepatocellular injury in this population. They underscore the potential importance of public health interventions aimed at reducing alcohol consumption, promoting the safe use of herbal medicines, and encouraging regular physical activity, which may collectively support liver health. A systematic review by Adeloye, *et al.* (2022) found that the pooled crude prevalence of physical inactivity in Nigeria was 52%, with rural dwellers exhibiting lower levels of inactivity compared to urban counterparts. This suggests that while physical activity may be less common in rural areas, it remains a significant factor influencing health outcomes. These demographic and lifestyle characteristics are crucial for understanding the context of non-viral hepatocellular injury in this population. They highlight the need for targeted public health interventions that address alcohol consumption, promote the safe use of herbal medicines, and encourage regular physical activity to mitigate the risk of liver dysfunction.

4.2 Pattern of Serum Albumin and Globulin Levels

Analysis of serum proteins in the study population revealed marked disturbances in hepatic synthetic function. Hypoalbuminemia (<3.5 g/dL) was observed in 77% of participants, with only 23% maintaining normal albumin levels. Albumin, synthesised exclusively by the liver, reflects the organ's synthetic capacity and nutritional status. Low serum albumin levels in the majority of participants suggest impaired hepatic protein synthesis, potentially due to hepatocellular injury, chronic inflammation, or nutritional deficiencies (Piano *et al*., 2019; Giannini *et al*., 2017). Elevated serum globulin (>3.5 g/dL) occurred in 69% of participants, indicating increased immunoglobulin production or a chronic inflammatory state. Hyperglobulinemia is commonly observed in liver injury and may reflect ongoing immune activation in response to hepatocellular damage, oxidative stress, or exposure to hepatotoxins such as alcohol and herbal remedies (Manka *et al.,* 2020). The combination of hypoalbuminemia and hyperglobulinemia represents a classic pattern of impaired synthetic function and heightened inflammatory activity in non-viral liver injury. The mean serum albumin concentration in this cohort was 3.12 ± 0.68 g/dL, total protein was 7.8 ± 0.9 g/dL, and the derived mean globulin value was 4.68 ± 0.78 g/dL. These values are consistent with similar studies in rural and semi-urban Nigerian populations, where non-viral hepatocellular injury was associated with significant reductions in albumin and elevations in globulin, reflecting both impaired liver function and increased immunologic response (Oyeleye *et al*., 2022; Lasebikan, 2016).

Lifestyle factors appeared to influence these alterations in serum protein levels. Alcohol consumption and herbal medicine use, reported by 38% and 42% of participants, respectively, are recognised risk factors for hepatocellular injury and disturbances in protein synthesis (Lasebikan, 2016; Oyeleye *et al.*, 2022). Conversely, regular physical activity, reported by only 27% of participants, was associated with relatively preserved albumin levels and lower globulin concentrations. This suggests that physical activity may exert a protective effect on liver function by improving hepatic perfusion, reducing systemic inflammation, and modulating oxidative stress (Adeloye *et al*., 2022).

From a public health perspective, these findings underscore the importance of lifestyle modification in preventing and managing non-viral hepatocellular injury. Targeted interventions such as alcohol reduction campaigns, safe use of herbal medicines, and promotion of regular physical activity could mitigate hepatic synthetic dysfunction and reduce the burden of liver disease in rural populations. Additionally, routine monitoring of serum albumin and globulin levels provides a simple, cost-effective approach to assess liver function and identify individuals at risk of complications.

4.3 Relationship between Serum Proteins and Etiological Factors

Stratification of participants according to the aetiology of non-viral hepatocellular injury revealed distinct patterns in serum protein profiles, providing insights into the underlying pathophysiology of different liver insults. Patients with alcoholic hepatitis and herbal toxicity exhibited the lowest mean serum albumin levels (2.85 ± 0.61 g/dL and 2.92 ± 0.65 g/dL, respectively), coupled with relatively high globulin concentrations. This pattern suggests that toxic insults not only impair hepatocyte protein synthesis but also induce a compensatory inflammatory response, reflected in globulin elevation. Alcoholic liver disease has been consistently associated with hypoalbuminemia due to hepatocyte injury, oxidative stress, and malnutrition, while herbal hepatotoxins may contain compounds that directly inhibit albumin synthesis or provoke immune-mediated hepatocellular damage (Stickel *et al*., 2017; Oyeleye *et al*., 2022). Participants with drug-induced liver injury (DILI) showed moderate hypoalbuminemia (3.05 ± 0.58 g/dL) and elevated globulin (4.72 ± 0.69 g/dL). This supports the concept that idiosyncratic or drug-mediated hepatotoxicity may partially compromise synthetic function, while simultaneously triggering immune responses (Manka *et al*., 2020). In contrast, autoimmune hepatitis and protein-energy malnutrition were associated with higher globulin levels but comparatively preserved albumin, indicating that chronic immune activation or nutritional deficits primarily drive globulin elevation, whereas hepatocyte synthetic capacity may be less severely impaired in early disease (Czaja, 2014). The statistically significant association between low albumin and toxic etiologies ($\chi^2 = 12.46$, $p = 0.002$) reinforces the utility of serum albumin as a sensitive biomarker of hepatocellular synthetic dysfunction, particularly in populations exposed to alcohol and herbal products. The lack of significant association between globulin elevation and etiology ($p = 0.07$) may reflect the fact that hyperglobulinemia is a nonspecific marker of chronic inflammation, present across diverse causes of liver injury (Giannini *et al*., 2017; Piano *et al*., 2019).

From a public health perspective, these findings highlight the importance of preventive strategies targeting modifiable risk factors. Community education on alcohol moderation, safe herbal medicine practices, and nutrition optimization could reduce hepatocellular injury and preserve liver synthetic function. Furthermore, monitoring albumin and globulin levels can provide a cost-effective method for early detection of hepatic dysfunction in resource-limited rural settings. Mechanistically, the pattern of low albumin with elevated globulin in toxin-related liver injury may be explained by a combination of hepatocyte loss, impaired transcription of albumin, and activation of B-cell-mediated immunoglobulin synthesis in response to ongoing inflammation. In autoimmune or nutritional etiologies, globulin elevation likely reflects persistent immune stimulation or compensatory protein production, while albumin synthesis is maintained until late-stage disease (Czaja, 2014; Manka *et al*., 2020).

4.4 Influence of Lifestyle Factors on Serum Protein Profiles

Lifestyle factors, including alcohol consumption, herbal medicine use, and physical activity, demonstrated significant associations with serum protein alterations in adults with non-viral hepatocellular injury. Participants reporting habitual alcohol intake (38%) exhibited notably lower serum albumin levels (2.85 ± 0.61 g/dL) and higher globulin concentrations (4.12 ± 0.85 g/dL) compared with non-alcohol users. This finding exposes the hepatotoxic effects of chronic alcohol consumption, which disrupt hepatocyte function and impair albumin synthesis, while simultaneously inducing inflammatory responses that drive globulin elevation (Stickel *et al*., 2017; Piano *et al*., 2019). Chronic alcohol intake also promotes oxidative stress, mitochondrial dysfunction, and malnutrition, all of which exacerbate hypoalbuminemia and contribute to impaired hepatic synthetic capacity (Giannini *et al.*, 2017). Similarly, the regular use of herbal preparations (42% of participants) was associated with hypoalbuminemia (2.90 ± 0.58 g/dL) and hyperglobulinemia (4.05 ± 0.78 g/dL). While traditional herbal remedies are widely used in rural Nigerian populations, many contain compounds with hepatotoxic potential, including alkaloids, glycosides, and other bioactive phytochemicals that can cause hepatocellular injury, immune activation, and oxidative stress (Oyeleye *et al*., 2022). These results corroborate previous studies showing that herbal hepatotoxins are significant contributors to non-viral liver injury and are often underrecognized as a public health concern.

Conversely, participants engaging in regular physical activity (27%) displayed relatively preserved serum albumin levels (3.35 ± 0.57 g/dL) and lower globulin concentrations (3.55 ± 0.63 g/dL) compared with sedentary individuals. This suggests that moderate physical activity may exert a protective modulatory effect on hepatic protein synthesis and inflammatory balance. Mechanistically, physical activity improves hepatic perfusion, enhances antioxidant defenses, reduces systemic inflammation, and may indirectly mitigate hepatocellular stress, thereby preserving albumin synthesis while dampening excessive immunoglobulin production (Adeloye *et al*., 2022; Moore *et al*., 2017). These findings highlight the complex interplay between lifestyle behaviors and hepatic function. Alcohol and hepatotoxic herbal products exacerbate liver injury and impair synthetic function, whereas regular physical activity may counteract some of these deleterious effects. From a public health perspective, interventions targeting alcohol moderation, safe herbal medicine practices, and promotion of physical activity could serve as cost-effective strategies to mitigate non-viral hepatocellular injury, particularly in rural and resource-limited settings. Furthermore, these results suggest that serum albumin and globulin profiles can serve as practical biomarkers for evaluating the impact of lifestyle factors on hepatic health, allowing clinicians to identify high-risk individuals and tailor counseling or interventions accordingly. Future longitudinal studies could further elucidate causal relationships and quantify the protective effects of structured physical activity programs on liver function.

5. CONCLUSION

Non-viral hepatocellular injury in rural Nigerian populations is commonly observed alongside lifestyle behaviours such as alcohol consumption, use of hepatotoxic herbal preparations, and low levels of physical activity. While this cross-sectional study cannot establish causation, these factors were frequently reported among participants and may be associated with liver dysfunction, highlighting areas for further investigation. Promoting safe practices, encouraging regular physical activity, and integrating accessible biomarker monitoring into community health programs could be considered in future public health strategies, although their effectiveness requires evaluation in longitudinal or interventional studies. These findings underscore the importance of cautious interpretation and the need for research to explore sustainable approaches for liver disease prevention at the community level.

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