International Journal of Clinical Science and Medical Research

ISSN(print): 2770-5803, ISSN(online): 2770-582X

Volume 02 Issue 05 May 2022

DOI: https://doi.org/10.55677/IJCSMR/V2I5-02/2022, Impact Factor: 5.868

Page No : 28-36

Plasma Magnesium Levels, Hypomagnesaemia, Cancers, Other Diseases and Associated Factors among Tanzanian Patients

Amos R. Mwakigonja[1], Baraka B. Ayubu[2], Walemba K. Livigha[3], Erica E. Thomas[4], Daniel A. Rodgers[5], Sam M. Mbulaiteye[6]

[1,2]Department of Pathology, School of Medicine, Muhimbili University of Health and Allied Sciences (MUHAS), Dar es Salaam, Tanzania

[3]Clinical Chemistry Unit, Core Laboratory Department, Central Pathology Laboratory (CPL), Muhimbili National Hospital (MNH), Dar es Salaam, Tanzania

[4]University of Maryland Baltimore (UMB), Maryland Global Initiatives Tanzania

[5]Medical Gastroenterology Unit, Department of Internal Medicine, Muhimbili National Hospital (MNH), Dar es Salaam, Tanzania

[6]Division of Cancer Epidemiology & Genetics, National Cancer Institute, National Institutes of Health (NIH), Department of Health and Human Services (HHS), Bethesda, Maryland, USA

ABSTRACT **Published Online: 06 May 2022**

Background: Although plasma magnesium deficiency may contribute to high cancer burden, data in sub-Saharan Africa is either scanty or unavailable which hinders intervention strategies. The aim of this study was to evaluate the association of magnesium derangements with cancers, other diseases/factors among patients at Muhimbili National Hospital (MNH), Tanzania.

Method: One month cross-sectional study (October 2019) involving magnesium testing. Demographics and laboratory results were retrieved and analyzed using SPSS. The cut-off point for deficiency was <0.66mmol/L and P-value ≤0.05 was statistically significant.

Results: Out of 972 samples tested, 264(27.2%) showed hypomagnesaemia, including males 103[39.2%] and females 161[61.0%] (M:F ratio=1:1.6). Males had lower mean plasma magnesium levels compared to females (P-value=0.048) with a decrease in magnesium levels with increasing age (P-value=0.000). A negative correlation between age and magnesium (P-value=0.004) suggested an age-and-sex-dependent discrepancy. Interestingly, hypomagnasaemia was more frequent in cancers (31.9%) and mean levels for cancers (0.7377mmol/L) appeared lower than for non-cancers (0.8622mmol/L) and infections (0.8686mmol/l) P-value=0.001. Solid tumors were mostly (96.2%) associated with hypomagnesaemia (P-value=0.001). Gastrointestinal (GI) cancers (43.4%), lymphomas (22.6%) and gynaecological malignancies (15.1%) were more frequently associated with hypomagnesaemia (P-value=0.000).

Conclusion: Almost one third of tested samples at MNH during the study period showed hypomagnesaemia, which was more associated with cancers, mostly solid including GI, lymphomas and gynecological cancers. Hypomagnesaemia seemed to increase with increasing age. Plasma magnesium derangements appeared more frequently in females. This is the first time the association of hypomagnesaemia with disease is documented from Tanzania. Larger studies will allow further elucidation.

KEYWORDS:
Magnesium, Hypomagnesaemia, Hypermagnesaemia, Diseases, Cancer, Tanzania

***Corresponding Author: Prof. Amos Rodger Mwakigonja, MD,MMed,PhD,FCPath ECSA**

Cite this Article: Amos R. Mwakigonja, Baraka B. Ayubu, Walemba K. Livigha, Erica E. Thomas, Daniel A. Rodgers, Sam M. Mbulaiteye (2022). Plasma Magnesium Levels, Hypomagnesaemia, Cancers, Other Diseases and Associated Factors among Tanzanian Patients. International Journal of Clinical Science and Medical Research, 2(5), 28-36

INTRODUCTION

Magnesium (Mg^{2+}) is the second most abundant intracellular cation and the fourth most abundant in the body [1] and has been shown to play an important role in immune response [2, 3]. As a result, Mg^{2+} deficiency has been linked to immune alterations and is suspected as a co-factor in various disease conditions including endemic Burkitt lymphoma

(BL), which is caused by uncontrolled infection with Epstein-Barr virus (EBV) [4-9]. The important role of Mg2+ in infections and cancer was discovered with the discovery of XMEN, a rare genetic disorder caused my mutations in the magnesium transporter 1 (MAGT1) gene, which plays a critical role Mg2+ metabolism [9, 10]. Patients with XMEN suffer from decreased intracellular free Mg 2+ transport, which was linked to signaling failure of natural killer activating receptor NKG2D in natural killer (NK) and CD8+ T cells and impaired cytolytic responses against EBV. These genetic failures apparently lead to impaired anti-EBV antiviral immunity in humans and predisposition to EBV-related neoplasia, including BL [5, 11, 12].

If the link between Mg^{2+} and uncontrolled infection of EBV due to genetic mutations occurs in the setting where Mg^{2+} deficiency is due to dietary reasons, it might be possible to reverse the health effects via dietary magnesium supplementation. Mg^{2+} deficiency has been reported in some African countries, including in 15% of 160 pregnant normotensive women attending a clinic in Ghana [13] and 68% of 101 patients admitted for emergency intra-abdominal surgery in Ghana [14]. While these studies suggest that mild Mg^{2+} deficiency is prevlent in Africa, incudng in countries with high eBL incidence [15], our understanding of the distribution Mg^{2+} deficiency in African populations, its causes and impacts on halth remains limited. In one conducted in Uganda, plasma Mg2+ deficiency (plasma level <1.8 mg/dl) was frequently observed and was associated with having elevated EBV levels and with eBL [9].

However, the lack of data on the distribution of total serum magnesum levels in African populations including in Tanzania makes it difficult to evaluate the potential role of supplementing Mg^{2+} as a way of improving population health. We conducted a study to obtain baseline data about plasma Mg^{2+} levels, and assess the frequency of hypomagnesaemia in unselected patients tested and treated at Muhimbili National Hospital (MNH). In the current study individual infections were not tested due to logistical limitations but further studies are anticipated. The aim of our study was to obtain data to motivate hypothesis-driven research to characterize the distribution Mg^{2+} deficiency in African populations and to determine its causes.

METHODOLOGY

Study population and data

The data were obtained from electronic laboratory records of all patients treated at Muhimbili National Hospital (MNH) during a one month period of October 2019 and tested for plasma levels of magnesium at the clinical chemistry laboratory. Limited sociodemographic information including, age, sex, diagnosis, and the magnesium levels results were extracted from the laboratory electronic database. Because MNH is a tertiary referral hospital, it is equipped with a clinical chemistry laboratory sufficient to provide high-quality data, but this also presents problems about catchment because the patients are likely to come from all over the country and to have more severe disease.

Plasma magnesium levels measurements

This was done according to the MNH Standard Operating Procedure (SOP) number "PROCEDURE-CHEM-001" also called Procedure for Examination of Basic Chemistry and Immune Assay Test Using Architect C4100 Analyzer.

The principle of magnesium measurement:

The architect system uses photometric, potentiometric and CMIA (Chemilumiscent Microparticle Immunoassay) technology to measure analyte concentrations in samples.

- **Photometric technology** is the measurement of the amount of light sample absorbs and involves passing a beam of light through a sample and measuring the intensity of the light that reaches a detector. Beers law establishes the mathematical relationship between the absorbance of the solution and the concentration of the analyte. The absorbance of the solution changes as the reaction progresses and measurement are taken when either all reactant is depleted then reaction is sable (end-point assay).
- **Potentiometry** is a detection technology used by the machine to measure electrical potential in a sample. The machine uses an ICT (Integrated Chip Technology) module to measure potentiometric assays (electrolytes). ICT Measurement is the process the machine uses to obtain millivolt readings and the convert them to assay specific conversion units. The measurement of ICT reference solution and ICT samples are used to calculate the assay results.
- **CMIA** (Chemilumiscent Microparticle Immunoassay) is a technology use to determine the presence of antigens, antibodies and analytes in samples. The reactants necessary for CMIA technology include:
    1. Paramagnetic micro particles coated with capture molecule (Antigen, Antibodies or viral particles) specific for analytes being measured.
    2. Acridium labeled conjugate
    3. Pre trigger solution and trigger solution

Magnesium normal ranges for Architect Chemistry Systems

Analyte	Normal Ranges	SI Unit
Magnesium	Male 0.66 - 1.07 Female 0.66 - 1.07 Male child 0.70 – 0.86 Female child 0.70 – 0.86	Mmol/L

Controls:

The magnesium control used was Magnesium 3P68 provided by Techno-path Manufacturing Ltd of Tipperary Ireland for Architect Chemistry Systems as below:

Architect Chemistry Systems			Level 1		Level 2		Level 3	
Analyte	**SI Units**	**Conv. Units**	**Mean**	**Range**	**Mean**	**Range**	**Mean**	**Range**
Magnesium 3P68	mmol/L	mg/dl	1.04	0.833-1.25	2.24	1.79-2.68	4.19	3.35-5.03

Thus for our study purposes, plasma levels below 0.66mmol/l was considered hypomagnesaemia for both adults and children respectively.

Variables evaluated:

- ***Dependent variable:***
  - Plasma Mg^{2+} levels
  - Clinical conditions/disease conditions
- ***Independent variable:***
  - Age/age-groups
  - Sex

Statistical analysis

Data were summarized using frequency tables and means to describe averages using the Statistical Package for Social Sciences (SPSS) version 20.0. Magnesium deficiency was defined as levels below 0.66mmol/l, based on information provided in the lab procedures section above. Furthermore, we assessed the frequency of the deficiency for sex, age-groups and clinical conditions. P-values of ≤0.05 was the cut-off point for statistical significance without adjustment for multiple comparisons.

Ethical considerations

Ethical clearance was obtained from the MUHAS IRB and the permission to collect data was obtained from the MNH management. No identifying patient information was collected in this study. Data were linked to laboratory numbers stripped off patient names and which were treated as being strictly confidential and their identities were never revealed.

RESULTS

We studied results from 972 patients and **table 1** shows general characteristics of the study subjects.

Table 1: Patients' General Characteristics

Variable	Subgroup	Frequency	Percentage
Sex	Male	423	43.5
	Female	549	56.5
	Total	**972**	**100.0**
Age (Years)	0-5	225	23.1
	6-20	97	10.0
	21-40	275	28.3
	41-60	200	20.6
	61+	175	18.0
	Total	**972**	**100**
Disease conditions	Cancers	163	16.8
	Non-Cancers	583	60.0
	Infections	74	7.6
	No Diagnosis	152	15.6
	Total	**972**	**100**
Cancer subgroups	Solid Tumors	51	96.2
	Leukemias	2	3.8
	Total	**53**	**100**

Table 2: Distribution of Plasma Magnesium Levels with Age-groups and Sex

	Age-group	Hypomagnesaemia N(%)	Normomagnesaemia N(%)	Hypermagnesaemia N(%)	Total N(%)
Age-groups in Years (P= 0.004)	0-5	38(14.4)	173(28.3)	14(14.4)	225(23.1)
	6-20	29(11.0)	59(9.7)	9(9.3)	97(10.0)
	21-40	87(33.0)	138(22.6)	50(51.5)	275(28.3)
	41-60	50(18.9)	131(21.4)	19(19.6)	200(20.6)
	61+	60(22.7)	110(18.0)	5(5.2)	175(18.0)
	Total	**264(27.1)**	**611(62.9)**	**97(10.0)**	**972(100)**
Sex (P= 0.0005)	Male	103(39.0)	291(47.6)	29(29.9)	423(43.5)
	Female	161(60.9)	320(52.4)	68(70.1)	549(56.5)
	M:F ratio	1:1.6	1:1.09	1:2.3	1:1.3
	Total	**264(27.1)**	**611(62.9)**	**97(10.0)**	**972(100)**

Association of plasma magnesium levels with sex

Plasma magnesium was low in 264 (27.1%) samples, but majority (60.9%, n=161/264) of patients with hypomagnesaemia were females, the rest being males which difference was statistically significant (p=0.0005) [**table 2**]. The M:F ratio (MFR) for both hypomagnesaemia and hypermagnesaemia were increased i.e. 1:1.6 and 1:2.3 respectively while it was almost 1:1 for normomagnesaemia and the whole cohort (**table 2**). This implies that overall females were more likely to have derangements in plasma Mg^{2+} levels (hypomagnesaemia or hypermagnesaemia) as compared to males however, at physiological (normomagnesaemia) levels, there seems to be no sex/gender disparities. Nevertheless, when it comes to the mean plasma Mg^{2+} levels, males seem to have lower levels as compared to females (**Table 3**).

Table 3: Distribution of the Mean Plasma Mg^{2+} Levels with Age Groups, Sex and Disease Conditions

Variable	Age-Group (years)	Mean Levels (mmol/L)	Range (mmol/L)
Age (P=0.000)	0-5	0.8221	2.27
	6-20	0.8035	2.19
	21-40	0.9153	3.67
	41-60	0.8133	2.72
	61-100	0.7277	0.96
Sex (P=0.048)	**Sex**	**Mean Levels (mmol/L)**	**Std. Deviation (mmol/L)**
	Male	0.8016	0.25149
	Female	0.8480	0.42880
	Overall Mean	0.8278	0.36303
Disease Group (P=0.001)	**Clinical Condition**	**Mean Levels (mmol/L)**	**Std. Deviation (mmol/L)**
	Cancer	0.7377	0.24957
	Non Cancer	0.8622	0.41556
	Infections	0.8686	0.32306
	No Diagnosis	0.7727	0.21767
	Overall Mean	0.8278	0.36303

Association of plasma magnesium levels with age

Overall the age of patients who were tested for magnesium levels ranged from 0 to 97 years, the peak age-group for the cohort was 21-40 years with a mean age of 34 years. The peak-age for both hypo- and hyper-magneaemia was 21-40 years (**table 2**) partly implying that, plasma Mg^{2+} imbalance is most frequent at that age group. Furthermore, majority (74.6%, n=197/264) were in the combined age-groups from

21-100 years while 25.4% (n=67/264) were juveniles 0-20 years of age (P-value<0.0001) [**table 2**]. This implies that at MNH, hypomagnesaemia seems to be more frequent in the older age-group compared to the younger (**table 2**). Moreover, for patients with hypomagnesaemia, the mean age was 37.7 years and the age-range was 0-85 years.

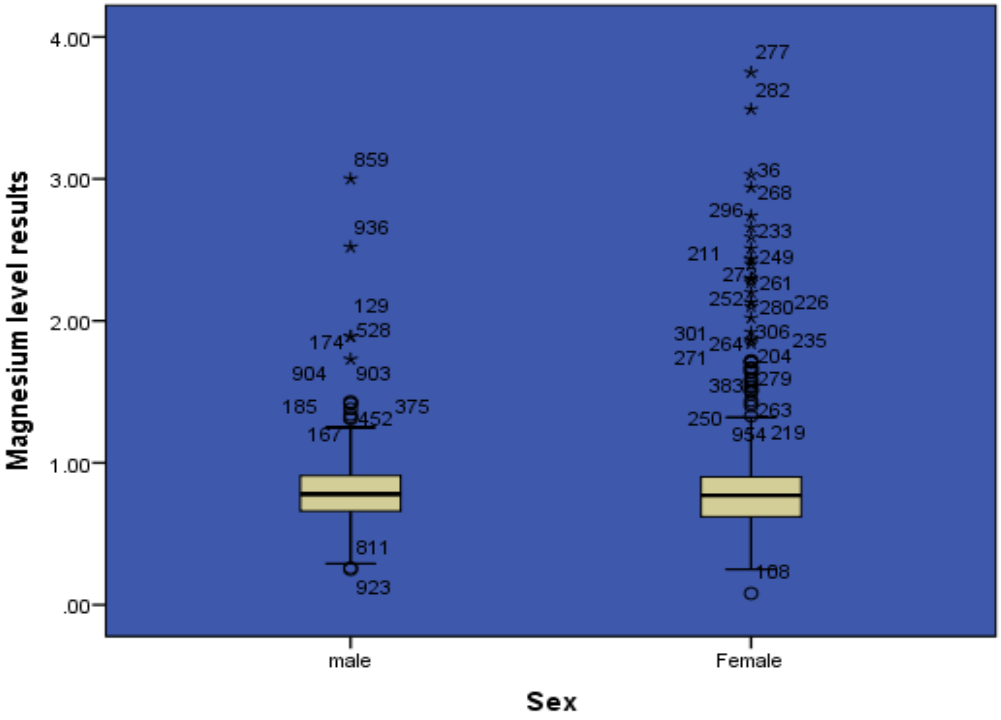
Association of the mean plasma magnesium levels with age

The mean plasma magnesium levels for the three groups of patients are indicated in **table 3** above and generally show that from the age of 21 years upwards, this was decreasing with increasing age (P-value=0.000) Similarly, a negative correlation of about -0.092 was noted between increasing age and plasma magnesium levels indicating that as one ages, the levels of magnesium decrease (P-value=0.004).

Association of the mean plasma magnesium levels with sex

The association mean plasma magnesium levels with sex at MNH is indicated in **table 3** above and generally shows that the overall mean to be 0.8278 mmol/L and that males appeared to have a lower level compared to females (**table 3 and figure 1**). Thus, these results generally suggest that females appeared to have higher levels of plasma magnesium when compared to males but also generally they were more frequently tested for plasma magnesium levels compared to males. These results, appear to suggest a sex discrepancy in plasma magnesium levels in the patients in our current cohort. Some of the reasons for this apparent disparity will partly be listed in the discussion section.

Figure 1: A Steam and Loaf plot for magnesium levels in association with sex showing females having higher levels as compared to males.



Association of plasma magnesium levels with disease groups

Clinical conditions are shown on **tables 1 & 3** above and generally, patients with non-communicable diseases (NCDs) including cancers and non-cancers were more likely to be tested for plasma magnesium levels as shown in **table 1** and that those with cancers had the lowest (0.7377mmol/l) levels compared to non-cancers (0.8622mmol/L) and infections (0.8686mmol/L) [P-value=0.001] (**table 3**). Upon further grouping of cancers into solid tumors and leukaemias, a great (96.2%, n=51/53) majority of patients with hypomagnesaemia had solid cancers while only two (3.8%) had leukaemias (P-value=0.001) [**Table 1**].

Furthermore, amongst those with hypomagnesaemia, the most common type of cancers were GI malignancies which covered 43.4%, and followed by lymphomas (22.6%) and gynaecological cancers (15.1%) P-value=0.000 (**Table 4**). Interestingly, for children below 18 years the most common (85.7%) cancer was lymphoma such that all lymphomas with low magnesium levels occurred at this age group. For adults aged 18-64 years, the most common (58.3%) cancers were GI followed by gynaecological (33.3%) cancers, while in the elderly group (65+ years) the most common (53.3%) neoplasm were GI cancers as well, but interestingly no gynaecological tumors at this age-group in the current cohort (P-value=0.000) [**Table 4**]. Thus all these results

appear to suggest that there is a kind of association between plasma magnesium levels (in particular hypomagnesaemia) and the occurrence of some disease groups.

Table 4: Distribution of hypomagnesaemia between age-groups and cancer subtypes

AGE-GROUPS		CHILD VS ADULT (N/%)			TOTAL (N/%)
		Under 18	18-64	65+	
CANCER TYPES	BLOOD CANCER	1(7.1)	0	1(6.7)	2(3.8)
	GYN CANCERS	0	**8(33.3)**	0	**8(15.1)**
	LYMPHOMA	**12(85.7)**	0	0	**12(22.6)**
	THYROID CANCER	0	0	1(6.7)	1(1.9)
	LUNG CANCER	0	1(4.2)	2(13.3)	3(5.7)
	GI CANCERS	1(7.1)	**14(58.3)**	**8(53.3)**	**23(43.4)**
	RENAL SYSTEM CANCERS	0	1(4.2)	3(20.0)	4(7.5)
TOTAL		**14(26.4)**	**24(45.3)**	**15(28.3)**	**53(100)**

P=0.000

DISCUSSION

This current study evaluated plasma magnesium levels and found that out that out of 972 samples tested, the proportion of samples with low levels (hypomagnesaemia) was about a third [27.1%, n=264]. On the other hand, about 10% had higher than normal magnesium levels (hypermagnesaemia). This finding in our current study, seem to show that hypomagnesaemia at Muhimbili National Hospital is more frequent compared to a previous American report indicating a prevalence 11.0% among hospitalized patients although in the same report, hypermagnesaemia was 9.3% which is almost the same as in our index study [16]. The discrepancy in hypomagnesaemia could partly be due to differences in sample sizes including sampling bias as well as possible disparities due to different populations and geographical locations since we don't have an African study to compare. This includes the fact that our current cohort included both outpatients and inpatients but in the American study it was only inpatients.

Regarding factors associated with hypomagnesaemia, the current results showed that the overall plasma Mg^{2+} levels decrease with increasing age The reasons for this partly include dietary Mg^{2+} deficiencies, which is common in the elderly population; reduced Mg^{2+} intestinal absorption, reduced Mg^{2+} in bone stores, as well as excess urinary loss with increasing age [17]. Our current study tried to elucidate the association of plasma Mg^{2+} levels with sex and found a possible sex-discrepancy or disparity which could partly be due to the contribution of hormonal changes in pregnancy as well as after menopause besides other sex-related biological differences [18-20].

Furthermore, regarding the relationship between serum magnesium levels and sex, our current results show that females had higher mean magnesium levels as compared to males. The observed differences could partly be contributed by magnesium sulphate supplementation to women with pre-eclampsia/pregnancy-induced hypertension (PIH), hormonal/metabolic differences, a possible role of lactation as well as possible gender dietary/lifestyle differences/habits [19]. Moreover, our current findings of more females having hypomagnesaemia amongst cancer patients, seem to tally with a previous study done in Taiwan which showed that the prevalence of low serum magnesium (<0.8mmol/L) was 12.3% and 23.7% for the males and females, respectively [21]. Thus our current findings appear to suggest that both hypermagnesaemia as well as hypomagnesaemia in our settings, are more frequently associated with female sex which agrees well with a more recent report showing an inverse relationship between serum magnesium levels and colorectal cancer in females but not in males [22]. However, no such magnesaemia data have yet been documented from the East African sub-region including Tanzania although, there is literature suggesting that total plasma magnesium concentrations are remarkably constant in healthy subjects throughout life but this was not evident in our current study [17].

Furthermore, as expected, the distribution of plasma magnesium levels varied across disease groups thus our current study showed that cancer patients had comparatively lower serum magnesium levels (0.7377mmol/L), compared to other clinical conditions. This is also well in agreement with a previous report estimating serum magnesium levels

of 25 patients with head and neck tumors and the results compared with a group of 25 healthy controls; which showed that the mean magnesium levels in cancer patients were significantly lower when compared to the control group [6].

Furthermore, our current findings appear show that among cancers; gastrointestinal (GI) malignancies in adults >18 years were more (43.4%) frequently associated with hypomagnesaemia. The second most frequent group of cancers with low magnesium levels were lymphomas (22.6%) and all of them occurred in children below 18 years of age in contrast to the GI group. The third group of cancers frequently associated with hypomagnesaemia were gynaecological malignancies (15.1%) all of which seemed to occur during the reproductive/sexually active years and none occurred in the elderly above 65 years of age. The reasons for this apparent age distribution may include hormonal, metabolic, nutritional as well as immunological factors influencing magnesium homeostasis and disease pathogenesis. Thus according to our index study, GI cancers, lymphomas and gynaecological cancers (in descending order) appear to be leading in having low magnesium levels. Furthermore, our current findings of GI cancers leading in hypomagnesaemia seem to tally with a previous report which said that laboratory and epidemiologic research, suggested a protective role of magnesium in colorectal cancer development and reported a higher risk of colorectal cancer among females with hypomagnesaemia, but not males implying that maintaining adequate serum magnesium levels may be important for colorectal cancer prevention [22]. Moreover, a retrospective was study done previously to evaluate whether hypomagnesemia (magnesium < 1.7mg/dL) at diagnosis was associated with inferior survival in patients with Burkitt lymphoma (BL) and as expected, it showed an inferior overall survival (OS)[23]. These reports on cancer and hypomagnesaemia seem to concur as well with our current finding of the same being more associated with solid tumors as compared to leukemias. Thus all these results and reports together, point to the fact that plasma magnesium levels need to be investigated in various disease conditions in our settings in order to further clarify the pathogenetic as well as therapeutic associations and thereby formulate intervention strategies, promote disease prevention and control as well as survival in our population. Our current study seems to be the first documentation associating serum magnesium levels among Tanzanian patients with disease and demographic factors.

CONCLUSION

This current study has pioneered in elucidating serum magnesium levels and associated factors in Tanzania and shows that close to one third of patients tested at MNH had hypomagnesaemia. Furthermore, plasma magnesium levels appeared to decrease with increasing age and a sex-related (females) disparity was observed. Moreover, hypomagnesaemia appears to be more frequent among cancers compared to other diseases including infections. Solid cancers appear to be frequently associated with hypomagnesaemia in particular of the GIT (for adults), lymphomas (for children) and gynaecological malignancies (in the reproductive age group). Our current results seem compare well reports from elsewhere although data from our own sub-region is still scanty. These findings can inform intervention strategies in various clinical and public health settings.

RECOMMENDATIONS

It is recommended that further and larger, translational and clinical research should be done in order to clarify more the contribution of magnesium derangements in tumorigenesis and the development of other diseases in our settings. Furthermore, studies on magnesium associations with specific types of cancers should be done including those that will formulate cost-effective interventions and allow prevention and treatment of cancers and other diseases/infections including COVID-19.

DECLARATIONS

Ethics approval and consent to participate

Ethical clearance of this study was sought and obtained from the MUHAS Ethical Committee and permission to conduct the study was sought from the relevant authorities at MNH. The study did not change the form of treatment planned for the patients. This was a retrospective descriptive study. No individual participant data is reported in the manuscript and patient information was handled in a strictly confidential way. No personal identifiers were used. No risk of harm to subjects and their rights and welfare were expected.

Consent for publication

Not applicable. No individual/personal participant data was reported in the manuscript (also refer the preceding item above).

Availability of data and materials statement

Data tables and information not containing personal identifiers is included in the manuscript. Furthermore, original/raw data including patients' clinical notes and histopathological results is available but will not be shared as is strictly confidential and participants did not consent for that original information to be published.

Competing interests

The authors declare that they have no competing financial interests.

Author's contributions

A.R.M, S.M.M and B.B.A designed the research. A.R.M, B.B.A and W.K.L collected, analyzed and interpreted the

data. B.B.A wrote the report. A.R.M wrote, corrected and submitted the manuscript and did the correspondence and also prepared, updated and formatted the Bibliography. S.M.M read the report and manuscript draft gave inputs. E.E.T and D.A.R read and corrected the manuscript and provided inputs.

Authors' information (optional)

A.R.M is Amos R. Mwakigonja **MD, MMed, PhD, FCPath ECSA** is an Associate Professor and Head of Pathology at MUHAS. **S.M.M** is Sam M. Mbulaiteye, **MBChB, MPhil, Mmed** Senior Investigator, Infections and Immunoepidemiology Branch, Division of Cancer Epidemiology & Genetics, National Cancer Institute, NIH, HHS. Bethesda, MD. **B.B.A** is Baraka B. Ayubu, **MD** is a Medical Officer who was then, an Undergraduate student doing research under A.R.M in the Department of Pathology, MUHAS. **W.K.L** is Walemba K. Livigha, **BMLS**, who is a Senior Health Laboratory Scientist in-charge of the Clinical Chemistry Lab at the Central Pathology Laboratory (CPL), MNH. **E.E.T** Erica Eden Thomas, **MD, MMed, MBA** is a Paediatrician and Paediatrics HIV/AIDS Advisor with the University of Maryland in Baltimore (UMB), Tanzanian Chapter. D.A.R is Daniel A. Rodgers, **MD**, is a Volunteer Registrar with the Medical Gastroentrology Unit, MNH.

Consent for publication

Not applicable. No individual/personal participant data was reported in the manuscript. No personal identifiers are used and this was a retrospective study.

Acknowledgements

I would like to convey my heartiest thanks to Mr. Justus Bwire, who was then In-Charge of the Clinical Chemistry Lab at the Central Pathology Laboratory (CPL), Muhimbili National Hospital (MNH) for his valuable assistance.

Funding: This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

REFERENCES

1. Swaminathan R: Magnesium metabolism and its disorders. *Clin Biochem Rev* 2003, 24(2):47-66.
2. Tam M, Gomez S, Gonzalez-Gross M, Marcos A: Possible roles of magnesium on the immune system. *Eur J Clin Nutr* 2003, 57(10):1193-1197.
3. Laires MJ, Monteiro C: Exercise, magnesium and immune function. *Magnes Res* 2008, 21(2):92-96.
4. Gile J, Ruan G, Abeykoon J, McMahon MM, Witzig T: Magnesium: The overlooked electrolyte in blood cancers? *Blood Rev* 2020, 44:100676.
5. Ravell JC, Chauvin SD, He T, Lenardo M: An Update on XMEN Disease. *J Clin Immunol* 2020, 40(5):671-681.
6. Mwakigonja AR, Kaaya EE, Heiden T, Wannhoff G, Castro J, Pak F, Porwit A, Biberfeld P: Tanzanian malignant lymphomas: WHO classification, presentation, ploidy, proliferation and HIV/EBV association. *BMC Cancer* 2010, 10:344.
7. Ravell J, Otim I, Nabalende H, Legason ID, Reynolds SJ, Ogwang MD, Ndugwa CM, Marshall V, Whitby D, Goedert JJ *et al*: Erratum to "Plasma magnesium is inversely associated with Epstein-Barr virus load in peripheral blood and Burkitt lymphoma in Uganda" [Cancer Epidemiol. 52 (2018) 70-74]. *Cancer Epidemiol* 2018, 55:192.
8. Riedel F, Zaiss I, Herzog D, Gotte K, Naim R, Hormann K: Serum levels of interleukin-6 in patients with primary head and neck squamous cell carcinoma. *Anticancer Res* 2005, 25(4):2761-2765.
9. Ravell J, Otim I, Nabalende H, Legason ID, Reynolds SJ, Ogwang MD, Ndugwa CM, Marshall V, Whitby D, Goedert JJ *et al*: Plasma magnesium is inversely associated with Epstein-Barr virus load in peripheral blood and Burkitt lymphoma in Uganda. *Cancer Epidemiol* 2018, 52:70-74.
10. Matsuda-Lennikov M, Biancalana M, Zou J, Ravell JC, Zheng L, Kanellopoulou C, Jiang P, Notarangelo G, Jing H, Masutani E *et al*: Magnesium transporter 1 (MAGT1) deficiency causes selective defects in N-linked glycosylation and expression of immune-response genes. *J Biol Chem* 2019, 294(37):13638-13656.
11. Chaigne-Delalande B, Li FY, O'Connor GM, Lukacs MJ, Jiang P, Zheng L, Shatzer A, Biancalana M, Pittaluga S, Matthews HF *et al*: Mg2+ regulates cytotoxic functions of NK and CD8 T cells in chronic EBV infection through NKG2D. *Science* 2013, 341(6142):186-191.
12. Li FY, Chaigne-Delalande B, Su H, Uzel G, Matthews H, Lenardo MJ: XMEN disease: a new primary immunodeficiency affecting Mg2+ regulation of immunity against Epstein-Barr virus. *Blood* 2014, 123(14):2148-2152.
13. Ephraim RKD, Osakunor DNM, Denkyira SW, Eshun H, Amoah S, Anto EO: Serum calcium and magnesium levels in women presenting with pre-eclampsia and pregnancy-induced hypertension: a case-control study in the Cape Coast metropolis, Ghana. *BMC pregnancy and childbirth* 2014, 14.
14. Djagbletey R, Boni F, Phillips B, Adu-Gyamfi Y, Aniteye E, Owoo C, Owusu-Darkwa E, Yawson AE: Prevalence and predictive factors of preoperative hypomagnesaemia among adult surgical patients in a large tertiary hospital in Ghana. *Bmc Anesthesiol* 2015, 15.

15. Emmanuel B, Kawira E, Ogwang MD, Wabinga H, Magatti J, Nkrumah F, Neequaye J, Bhatia K, Brubaker G, Biggar RJ *et al*: African Burkitt lymphoma: age-specific risk and correlations with malaria biomarkers. *The American journal of tropical medicine and hygiene* 2011, 84(3):397-401.
16. Wong ET, Rude RK, Singer FR, Shaw ST, Jr.: A high prevalence of hypomagnesemia and hypermagnesemia in hospitalized patients. *Am J Clin Pathol* 1983, 79(3):348-352.
17. Barbagallo M, Belvedere M, Dominguez LJ: Magnesium homeostasis and aging. *Magnes Res* 2009, 22(4):235-246.
18. Browne PC, Linfert JB, Perez-Jorge E: Successful Treatment of Preterm Labor in Association with Acute COVID-19 Infection. *Am J Perinatol* 2020, 37(8):866-868.
19. Kreepala C, Kitporntheranunt M, Sangwipasnapaporn W, Rungsrithananon W, Wattanavaekin K: Assessment of preeclampsia risk by use of serum ionized magnesium-based equation. *Ren Fail* 2018, 40(1):99-106.
20. Tang CF, Ding H, Jiao RQ, Wu XX, Kong LD: Possibility of magnesium supplementation for supportive treatment in patients with COVID-19. *Eur J Pharmacol* 2020, 886:173546.
21. Wang JL, Weng YL, Pan WH, Kao MD: Trends and nutritional status for magnesium in Taiwan from NAHSIT 1993 to 2008. *Asia Pac J Clin Nutr* 2011, 20(2):266-274.
22. Polter EJ, Onyeaghala G, Lutsey PL, Folsom AR, Joshu CE, Platz EA, Prizment AE: Prospective Association of Serum and Dietary Magnesium with Colorectal Cancer Incidence. *Cancer Epidemiol Biomarkers Prev* 2019, 28(8):1292-1299.
23. Gile J, Ruan G, Abeykoon J, McMahon MM, Macon WR, Witzig TE: Hypomagnesemia is associated with an increased risk of early clinical failure in patients with Burkitt lymphoma. *Leuk Lymphoma* 2020, 61(9):2274-2276.