

Nutritional Status of Inmates in the Central Prison of Mbuji-Mayi, Democratic Republic of Congo

Muasa Patoka Guillaume Kalonji^{1,2,3,*}, Gérard De Coninck⁴, Léon Okenge Ngongo⁵, Félicien Ilunga Ilunga⁵, Adelin Albert¹, Didier Giet⁶

¹University of Liège, Department of Public Health Sciences, Belgium

²Official University of Mbuji-Mayi, School of Public Health, DR Congo

³Mbuji-Mayi Higher Institute of Medical Engineering, DR Congo

⁴University of Liège, Faculty of Law, Political Science and Criminology

⁵Kinshasa Higher Institute of Medical Engineering, DR Congo

⁶University of Liège, Department of General Practice, Belgium

Corresponding author:

Guillaume M. Kalonji, Department of Public Health, University of Liège – Quartier Hôpital, Avenue Hippocrate 13 - B23, 4000 Liège, Belgium. Fax +32 (0)4 366 25 96 and cell phone: +32 (0)474 64 63 14.

Keywords:

health condition, prison, nutrition, Democratic Republic of Congo

Received: Aug 08, 2021

Accepted: Sep 03, 2021

Published: Sep 06, 2021

Editor:

Sheyda Najafi, Dept. of Pharmaceutical Care, College of Pharmacy, Tehran University of Medical Sciences, Imam Khomeini Hospital Complex, Tehran, Iran.

DOI:

10.14302/issn.2379-7835.ijn-21-3926

Abstract

Background

The nutritional situation in prisons of developing countries and the health status of inmates remain a major human rights concern. The objective of the study was to assess the nutritional status of inmates jailed in a prison of the Democratic Republic of Congo (DRC).

Methods

This cross-sectional study was conducted over a 4-month period in the Central Prison of Mbuji-Mayi, DRC. Three hundred inmates were selected according to the Malnutrition Universal Screening Tool (MUST). Severe malnutrition was defined according to Buzby index and Nutritional Risk Index (NRI). Data were analyzed by Stata™ (version 12.0).

Results

The inmates were aged between 18 and 70 years and primarily males (88.7%). Of them, 24% were suffering from severe malnutrition and 62% of moderate malnutrition as based on the NRI. At the time of study, 88% of inmates were incarcerated for more than 6 months. Multivariate logistic regression analysis showed that factors independently associated with severe malnutrition were incarceration of more than 6 months (OR=5.1; 95% CI [1.5-17.4]), origin of food (prison vs. family or NGO) (OR=4.7; 95% CI [1.6-13.8]) presence of tuberculosis, human immunodeficiency virus and/or intestinal infections (OR=2.6; 95% CI [1.4-4.7]).

Conclusions

The nutritional situation in the Central Prison of Mbuji-Mayi is precarious. There is urgent need to supply enough nutrient-rich food to improve health of inmates.

Background

Food is a crucial element in the life of inmates. It plays a key role in their physical and mental health [1]. Nutritional deficiency remains a daily challenge in prisons of developing countries [2]. A poor health condition among inmates is partly linked to an insufficient food intake and to precarious conditions in prison settings [3]. The lack of food and medicine supply affects seriously inmates' health and life. In the Democratic Republic of Congo (DRC), apart from regular overcrowding problems noted in several central prisons, food is a main issue in the Congolese prison system. According to the United Nations Stabilization Mission in the DRC (MONUSCO) report on detention conditions in DRC prisons and jails, serious deficiencies in food, hygiene and healthcare continue to convert some prisons in real homes of the dead [4]. Most inmates are in poor health and diseases affect organisms weakened by malnutrition. Despite the warning signs launched by reports of the United Nations Organization Mission in the DRC (MONUC), Human Rights Section, in April and November 2004, the situation is far from being improved in prisons twelve years later [5]. In this particular field, international and national standards continue to be violated with dramatic consequences

(deadly for many inmates).

Nutritional status is deplorable because several years ago the Congolese state stopped providing food to inmates in numerous settings; only their family, the International Committee of the Red Cross (ICRC), charitable organizations/people, non-governmental organizations (NGOs) and religious organizations help supporting inmates [6]. Due to a high population density, poor prison conditions and insufficient budget assigned to food purchase, numerous inmates suffer from malnutrition. In the Central Prison of Mbuji-Mayi, food is only provided once a week. In April 2015, twelve people died as a result of malnutrition and lack of medical care. In a recent study performed in that prison, known as the biggest of Kasai Oriental province, 368 inmates out of 733 (50.2%) had a body mass index (BMI) below 18.5 kg/ m² [7]. As few data on that subject are available, and the recent situation being unknown, the present study aimed at assessing malnutrition, especially the severe form, in prison, through the evaluation of inmates' nutritional status, in order to identify severe malnutrition and associated factors in the Central Prison of Mbuji-Mayi.

Methods

Study Design and Conduct

This prospective observational study was performed between 1 December 2019 and 30 March 2020 in the Central Prison of Mbuji-Mayi, capital city of Kasai Oriental province, DRC. The prison was built in 1952 with an accommodation capacity of 150 prisoners. Currently, it hosts nearly five times its initial capacity (650 inmates) [8]. Buildings are outdated and risks of collapse are real. Dorms are overcrowded; there is neither light nor ventilation. There are 8 dorms, with a mean of 70 inmates per dorm, 7 showers and 5 toilets, but with no doors. Food is provided once a day, but in insufficient quantities and poor in nutrients [5,7].

Study Population

The study involved inmates aged ≥ 18 years old. To determine subjects eligible for the study, we used the multiparameter index known as the Malnutrition

Universal Screening Tool (MUST). Out of 650 inmates present by the time of study, 300 of them were selected based on a MUST score ≥ 1 . This group was submitted to a second evaluation test, the Nutritional Risk Index (NRI) or Buzby index, with the aim of determining the proportion of inmates suffering from severe malnutrition.

Laboratory Analysis Method

All biochemical and haematological tests (including Complete Blood Count [CBC], CD4 cell count, HIV viral loads and C-reactive protein [CRP] concentrations, albumin) were performed at the application laboratory department of the Higher Institute of Medical Engineering (ISTM/MBM). Whole blood (3.5 mL) was collected in serum gel separator tubes and centrifuged at 3500 rpm for 10 minutes, and the serum was separated and processed for albumin, using standard methods. CD4 counts were determined using a FACS counter. The diagnosis of HIV infection was determined by having a positive result for HIV-1 antibody ELISA kits which was confirmed by a positive result again with the same test. Sputum samples were tested by fluorescence microscopy, the Xpert MTB/RIF test and cultured in mycobacterial growth indicator tubes. Urine was tested with Xpert on fresh urine samples (2.0 ml) as well as on frozen samples (30-40 ml) that were thawed and concentrated by centrifugation. All diagnostic tests were performed by independent operators ignoring clinical information and other test results. HIV, TB and Albumin results were made available to the prison medical team to inform treatment decisions.

Data Collection

Data were collected by health professionals assigned to the prison medical centre and BSc students in laboratory science, under the supervision of a medical biologist from the Mbuji-Mayi Higher Institute of Medical Engineering. Investigators were previously trained on the purpose of the study, methodology of data collection and laboratory sampling techniques.

A directive interview grid was used to collect

sociodemographic information. Anthropometric measures were systematically registered for all inmates included in the study. The following data were collected: age, sex, height (m), weight (kg), education level, jail sentences (months), inmate status, number of daily meals, origin of food (prison, family or NGO), type of infection (tuberculosis [TB], Human Immunodeficiency Virus [HIV] or intestinal infections), smoking status and alcohol consumption. Venous blood was sampled in all study inmates to measure biochemical and haematological tests (serum albumin), to determine the HIV status.

Assessment of the Nutritional Status

The body mass index (BMI) was defined as weight (kg) divided by height (m) squared and expressed in kg/m^2 . The Nutritional Risk Index (NRI) was calculated by the formula:

$$NRI = 1.519 \times \text{serum albumin (g/l)} + (0.417 \times [\text{current weight}/\text{usual weight}] \times 100)$$

The NRI score was categorized as “normal nutritional status” ($NRI > 97.5$), “moderate malnutrition” ($83.5 < NRI < 97.5$) and “severe malnutrition” ($NRI < 83.5$) [9,10]. The MUST index initially used to select eligible subjects for the study is a screening tool which consists in determining the weight loss of undernourished adults at risk of developing malnutrition. Five steps were followed depending on the scores assigned (four of them being helpful in the screening): (i) the first step consists in measuring height and weight to estimate the BMI; (ii) the second step consists in recording the unintentional weight loss (%) and assigns the corresponding score; (iii) the third step determines if the subject suffers from an acute disease and assigns the corresponding score; (iv) the fourth step consists in adding the scores obtained at steps 1 to 3 to obtain a global malnutrition risk; (v) finally, the fifth step involves orienting the management. The risk is considered as low for a $MUST=0$, moderate if $MUST=1$ and high if $MUST \geq 2$ [11,12]. Inmates suffering from severe malnutrition were sent to Dipumba General Hospital for an appropriate

management.

Ethics Approval and Consent to Participate

The study was approved by the Mbuji-Mayi Inter-University Ethical Committee (COE-IU) (No Approbation: MBM/COE-IU/027/2014) and performed with the consent of local authorities (Provincial Ministries of Health and Justice). All prisoners provided a free and informed oral consent for their participation. They were explained the nature, objective, and duration of the study, as well as what we expected from them; furthermore, they were also given some time for reflection. When malnutrition was diagnosed, the patient was provided immediate healthcare. All terms of data use were respected in accordance with the DRC law and requirements. Anonymity was guaranteed.

Statistical Analyses

Results were expressed by mean and standard deviation (SD) for quantitative variables and as numbers (%) for categorical findings. The Chi-squared test or a Fisher exact test was used to analyze contingency tables. Odds ratios (OR) and their 95% confidence interval (95% CI) were estimated by univariate and multivariate logistic regression analyses. A backward stepwise variable selection procedure was applied to identify factors independently associated with a high risk of severe malnutrition. Results were considered at the 5% critical level ($P \leq 0.05$). Data were analyzed by Stata™ (version 12.0).

Results

The 300 inmates, mostly men (88.7%), had a mean age of 33 ± 10 years. Inmates aged between 30 and 49 represented 48.7% followed by those under 30 who represented 43.3%. About 90% of them were jailed for more than 6 months. An infection, such as TB, HIV and/or intestinal infection, was recorded in more than half of them (61%). Five inmates (1.7%) died from severe malnutrition during the study period (Table 1).

Based on BMI, most inmates (51.3%) were underweighted. When considering NRI categories, malnutrition was severe among 24.0% of inmates while it

was moderate for 62.0% of them (Table 2).

As seen in Table 3, no significant difference was found between inmates who were suffering from severe NRI-based malnutrition and the others, when considering sociodemographic variables, smoking status and alcohol consumption. Severe malnutrition however was more frequent among inmates whose meals were provided by the prison, for those who were suffering from TB, HIV and/or intestinal diseases, and when the length of incarceration was ≥ 6 months. Logistic regression analysis coupled with a backward variable selection procedure confirmed that length of incarceration > 6 months, origin of meals from prison and presence of infection were the only independent factors significantly associated with malnutrition. Inmates who had spent more than 6 months in prison had a 5-fold higher risk of malnutrition compared to other inmates. The risk of developing severe malnutrition was 4.7 times higher for inmates whose meals were exclusively provided by the prison. The presence of TB, HIV and/or intestinal infections was also significantly associated with the risk of malnutrition (adjusted OR = 2.6)(table 4).

Discussion

This study conducted in the Central Prison of Mbuji-Mayi (DRC) assessed the nutritional status of inmates with the goal to identify subjects with severe malnutrition and to highlight potentially associated risk factors. The overall prevalence of severe malnutrition reached 24%, while moderate malnutrition affected 62% of inmates. Similar results were reported by the NGO “Doctors without Borders” in Guinea: severe malnutrition reached 22% in Mamou, 21% in Guéckédou and 13% in Boké [13]. The prevalence observed in Mbuji-Mayi was slightly lower compared to other African reports. Olubodun et al. [14] estimated a 48.1% prevalence of malnutrition in the prison of a Nigerian developing community. On the other hand, a higher prevalence (46.2%) was reported in North Gondar and in northeast Ethiopia [15]. Such difference could be explained by the wide range of tools used to assess nutritional risk and

Table 1. Demographic and clinical patterns of liver disease admitted at Ras Desta Damtew Memorial hospital, Addis Ababa-Ethiopia from February 2015 to April 2020

Parameter	Mean \pm SD	Number (%)
Sex (male)		266 (88.7)
Age (years)	33 \pm 10	
< 30		130(43.3)
30-49		146(48.7)
\geq 50		24(8.0)
Incarceration (> 6 months)		264 (88.0)
Smoking		60 (20.0)
Alcohol consumption		44 (14.7)
Origin of meals (prison)		256 (85.3)
Infection(s) [‡]		188 (61.3)
Death		5 (1.7)

*Infection (tuberculosis [TB], Human Immunodeficiency Virus [HIV] or intestinal infections

Table 2. Nutritional status of study inmates (N=300)

Parameter	Category	Number (%)
BMI (kg/m ²)	<18.5	154 (51.3)
	18.5-24.9	64 (21.3)
NRI	<83.5	72 (24.0)
	83.5-97.5	186 (62.0)

BMI = Body mass index; NRI = Nutritional Risk Index

Table 3. Inmates characteristics according to their NRI-based nutritional status (N=300)

Parameter	NRI nutritional status		Unadjusted OR (95%CI)*	P-value*
	Severe (< 83.5)	Non severe (≥ 83.5)		
Sex				0.076
	Male	68 (25.6)	198 (74.4)	2.6 (0.9-7.6)
	Female	4 (19.8)	30 (80.2)	1.0
Age (years)				0.38
	<30	28 (21.5)	102 (78.5)	1.0
	≥30	44 (25.9)	126 (74.1)	1.3 (0.7-2.2)
Smoking				0.89
	Yes	14 (23.3)	46 (77.7)	0.9 (0.5-1.08)
	No	58 (24.2)	182 (75.8)	1.0
Alcohol consumption				0.051
	Yes	14 (31.8)	30 (68.2)	1.6 (0.8-3.2)
	No	58 (22.7)	198 (77.3)	1.0
Origin of meals				0.012
	Prison	68 (26.6)	188 (73.4)	3.6 (1.2-10.5)
	Family or NGO	4 (9.1)	40 (90.9)	1.0
Presence of infection				0.006
	Yes	54 (29.4)	130 (70.6)	.3 (1.2-4.1)
	No	18 (15.5)	98 (84.5)	1.0
Length of incarceration (months)				0.019
	< 6	3 (8.3)	33 (91.7)	1.0
	≥ 6	69 (26.1)	193 (73.9)	3.9 (1.2-13.1)

*Chi square test; NRI: Nutritional Risk Index; OR =1.0 : reference category , OR obtained by univariate logistic regression analysis,

Table 4. Factors independently associated with severe malnutrition based on NRI (N=300)

Parameter	Adjusted OR* (95% CI)	P-value
Length of incarceration (months)		
≤ 6	1.0	
> 6	5.1 (1.5-17.4)	0.009
Origin of meals		
Prison	4.7 (1.6-13.8)	0.005
Family or NGO	1.0	
Presence of infection		
Yes	2.6 (1.4-4.7)	0.002
No	1.0	

*OR=Odds ratio derived by multivariate logistic regression analysis; CI=confidence interval. OR =1.0 : reference category.

other factors such as those related to organization and conditions of detention in these prison settings.

Adequate nutrition is a fundamental human right; inmates should benefit from healthy food for a better health. Our study revealed that the origin of meals was closely related to severe malnutrition. Inmates who were exclusively fed with prison meals were 5 times more at risk to develop severe malnutrition compared to those receiving meals prepared by their family or an NGO. The lack of access to a diversified food, rich in nutrients, is frequently observed in DRC prisons. The budget for food is almost non-existent. Enough food, as a fundamental right, is denied to most inmates; thus, weight loss and death occur, especially among inmates infected by TB and/or HIV [5]. Inmates who were initially fragile because of their health status and those who had spent more than 6 months in prison were 5 times more likely to suffer from severe malnutrition compared to other inmates. A long-lasting incarceration is a risk factor, especially in DRC prisons, which have become places of deprivation of all fundamental rights despite the UN Charter [16]. Such conclusion is in line with the results of previous studies performed in Gondar and Bahirdar, in northwest Ethiopia [15]. Our results also showed that

inmates who were suffering from HIV, TB and/or intestinal infections were twice more likely to develop severe malnutrition; this is due to the lack of protein rich meal, loss of appetite, vomiting and nausea, which are frequent consequences of antiretroviral and anti-tuberculosis drugs-related secondary effects, the difficulty swallowing because of oral candidiasis or ulcer [17-19]. In our case, no association was evidenced between sex, age of inmate, tobacco smoking or alcohol consumption, and the occurrence of severe malnutrition in prison. Contrary to our results, some authors observed that women in prison had a muscular mass less developed and a higher proportion of total body fat compared to men, for an equivalent BMI [20]. This could increase the prevalence of malnutrition in men, as sex and muscular mass can affect the relation between BMI and body fat [20]. A significant association between infections and severe malnutrition was highlighted in our study: inmates suffering from TB, HIV and/or intestinal infections were 3 times more likely to develop severe malnutrition. Similar observations were documented in previous studies [21-25]. The HIV/TB complex and malnutrition, especially in DRC prisons, weaken inmates and are responsible for several deaths. It should be noted that during the investigation period,

5 inmates (1.7%) died in unexplained cachexic conditions. Our observations confirm previous findings in the way that poor and insufficient food increases the risks of exposure to a disease and accelerates its evolution [4]. A 2004 study performed in the Guinean prison named 'Central House' showed that 10 to 15% of inmates were suffering from malnutrition; seven inmates were dying per month, either of malnutrition or of diseases [25]. The poor conditions of detention were exacerbated by the lack of appropriate and in time-health care. In prison, medical care is generally of poor quality. Food, as a fundamental right, is essential for inmates and should receive more attention. Food is one of the most important aspects in the life of inmates; it helps them disconnect from daily routine but also decreases hostility and antisocial behaviour.

Limitation of the Study

The range of tools used to assess nutritional risk is an obstacle to the comparison with other studies. Differences related to scales, scoring system and thresholds selected restrict the possibility to compare prevalence data. It is important to note that comparing prevalence with other studies is also limited due to differences in age categories and the threshold defining severe malnutrition in the elderly. In our study, the usual weight was estimated on the basis of what people told the investigators, due to lack of knowledge on the weight of several inmates upon their arrival at the prison.

Conclusion

This study showed that 25% of inmates of the Central Prison of Mbuji-Mayi (DRC) were suffering from severe malnutrition. Health status of inmates receiving homemade or NGO meals was less alarming compared to inmates whose meal was provided by the prison, in low quantity and once a day. Malnutrition is the major cause of morbidity and mortality in developing countries. An incarceration of more than 6 months expose inmates to malnutrition, especially individuals suffering from TB, HIV and/or intestinal infections. A correct and

well-balanced food, in sufficient quantity, is crucial to avoid exposure to severe malnutrition and potential mortality. The involvement of national and regional authorities is essential to avoid transforming the prison rehabilitation centre in a site of infection, with all negative consequences that may arise.

Abbreviations

DRC: Democratic Republic of Congo, MUST: Malnutrition Universal Screening Tool

NRI: Nutrition Risk Index, OR: Odds ratio, CI: Confidence interval, Monusco: United Nations Mission Stabilization Mission in Congo (DRC), Monuc: United Nations Mission Stabilization Mission in Congo (DRC); ICRC: International committee of the Red Cross, NGOs: Non-Governmental Organizations, BMI: Body mass index, TB: Tuberculosis, MBM: Mbuji-Mayi, HIV: Human immunodeficiency virus, UN: United Nations, BSc: Bachelor, COE-IU Inter-University Ethical Committee

Availability of Data and Materials

The dataset(s) supporting the conclusions of this article is (are) included in the article (and its additional file(s): Tables).

Competing Interests

The authors declare that they have no competing interests.

Funding

No funding sources.

Authors' Contributions

MGK is the main author: he designed the study, participated to the data collection and analysis. AA, GDC, LO and DG supervised the overall design and conduct of the work. FII took part to the data collection and statistical analysis. All authors were involved in the preparation of the manuscript, edition, and finalization of the version to be published and agreed to be accountable for all aspects related to the integrity of the work. All authors read and approved the final manuscript.

Acknowledgements

We thank all healthcare professionals from the hospital to the central prison in Mbuji-Mayi. We also thank the authorities of the central prison for giving us access to the prison. We acknowledge the guidance and supervision received from the Mbuji-Mayi Higher Institute of Medical Engineering.

References

1. Amy B. Smoyer; Kjær Minke L (2015). Food systems in correctional settings, World Health Organization Regional Office for Europe, Copenhagen Denmark, p.30;: http://www.euro.who.int/__data/assets/pdf_file/0006/292965/Food-systems-correctional-settings-literature-review-case-study.pdf (accessed on Nov 20, 2020)
2. Gould C, Tousignant B, Brian G, et al (2013) Cross-sectional dietary deficiencies among a prison population in Papua New Guinea. *BMC Int Health Hum Rights*. <https://doi.org/10.1186/1472-698X-13-21>
3. Geetha. K & Mushtari Begum. J (2006) Energy Intake and Energy Expenditure of Prisoners Involved in Different Worksheds, *Journal of Human Ecology*, 19:2, 113-115, DOI: 10.1080/09709274.2006.11905865
4. United Nations Organization Stabilization Mission in the DR Congo (MONUSCO) (2015). Report of the United Nations Joint Human Rights Office on Human Rights and Fundamental Freedoms during the pre-electoral period in the Democratic Republic of the Congo between 1 January and 30 September. http://www.ohchr.org/Documents/Countries/CD/UNJHRODecember2015_en.pdf ((accessed on Nov 20, 2020)).
5. United Nations Organization Mission in the Democratic Republic of the Congo (MONUC) (2005). Report on conditions of detention in prisons and jails of the Democratic Republic of the Congo [in French], p. 42; https://monusco.unmissions.org/sites/default/files/old_dnn/MONUC-French/Activites/HumanRights/Rapport_sur_les_prisons_octobre_2005-%20FR.pdf ((accessed on Nov 20, 2020))
6. Comité International de la Croix-Rouge (2013).Rapport d'activité 2013 : opérations majeures. <https://www.icrc.org/fr/doc/resources/documents/annual-report/icrc-annual-report-2013-operational-highlights.htm>. (accessed on Nov 22, 2020)
7. Kalonji M.G, De Coninck G, Okenge NL et al (2016). Prevalence of tuberculosis and associated risk factors in the Central Prison of Mbuji-Mayi, Democratic Republic of Congo, *Trop Med Health*. 44: 30.DOI 10.1186/s41182-016-0030-9
8. Kalonji, G., Ngongo Okenge, L., Ilunga-Ilunga, F., Albert, A. & Giet, D. (2019). Facteurs associés à la survie en milieu pénitentiaire : étude en République démocratique du Congo. *Santé Publique*, 31, 715-722. <https://doi.org/10.3917/spub.195.0715>
9. Ryu, S. W., & Kim, I. H. (2010). Comparison of different nutritional assessments in detecting malnutrition among gastric cancer patients. *World journal of gastroenterology*, 16(26), 3310–3317. <https://doi.org/10.3748/wjg.v16.i26.3310>
10. Allard, L., Ouedraogo, E., Molleville, J., Bihan, H., Giroux-Leprieur, B., Sutton, A., Baudry, C., Josse, C., Didier, M., Deutsch, D., Bouchaud, O., & Cosson, E. (2020). Malnutrition: Percentage and Association with Prognosis in Patients Hospitalized for Coronavirus Disease 2019. *Nutrients*, 12(12), 3679. <https://doi.org/10.3390/nu12123679>
11. British Association for Parenteral and Enteral Nutrition (BAPEN) Malnutrition Universal Screening Tool (MUST) (2015). British Dietetic Association, the Royal College of Nursing. www.bapen.org.uk (consulted on May 03, 2016)
12. Emad FA, Fahad Javed, Balaji Pratap, Dan Musat. (2011). Malnutrition as assessed by nutritional risk index is associated with worse outcome in patients admitted with acute decompensated heart failure: an

- ACAP-HF data analysis, Heart International; 6:e2 doi:10.4081/hi.2011.e2
13. Doctors without Borders (MSF) (2009)'No food, no medicine to death'; MSF reveals a nutritional and medical emergency in Guinean prisons [in French]; Brussels, Feb 2009; pp14 Access: http://www.msf.org/sites/msf.org/files/old-cms/source/countries/africa/guinea/2009/reports/MSF_Prisons_Guinee.pdf (consulted on Nov 20, 2016).
 14. Olubodun JO, Akinsola HA, Adeleye OA.(1996). Prison deprivation and protein nutritional status of inmates of a developing community prison. *Eur J Clin Nutr.* 50:58-60.
 15. Moges.B, Amare. B; Asfaw.F et al (2012). Prevalence of smear positive pulmonary tuberculosis among prisoners in North Gondar Zone Prison, northwest Ethiopia. *BMC Infect Dis,* 12:352. <https://doi.org/10.1186/1471-2334-12-352>
 16. Office of the United Nations High Commissioner for Human Rights (2005). *Human Rights and Prisons – Manual on Human Rights Training for Prison Officials* (section 3: pp52-53), United Nations, New York and Geneva, <http://www.ohchr.org/Documents/Publications/training11en.pdf> (Acceded on 25 September 2020)
 17. Van der Pols-Vijlbrief, R., Wijnhoven, H. A., Molenaar, H., & Visser, M. (2016). Factors associated with (risk of) undernutrition in community-dwelling older adults receiving home care: a cross-sectional study in the Netherlands. *Public health nutrition,* 19(12), 2278–2289.<https://doi.org/10.1017/S1368980016000288>
 18. Hussain, H., Akhtar, S., & Nanan, D. (2003). Prevalence of and risk factors associated with Mycobacterium tuberculosis infection in prisoners, North West Frontier Province, Pakistan. *International journal of epidemiology,* 32(5), 794–799. <https://doi.org/10.1093/ije/dyg247>
 19. Koethe, J. R., & Heimbürger, D. C. (2010). Nutritional aspects of HIV-associated wasting in sub-Saharan Africa. *The American journal of clinical nutrition,* 91(4), 1138S–1142S. <https://doi.org/10.3945/ajcn.2010.28608D>
 20. Schaible UE, Kaufmann SHE (2007). Malnutrition and Infection: Complex Mechanisms and Global Impacts. *PLoS Med* , 4: e115. <https://doi.org/10.1371/journal.pmed.0040115>
 21. Scalcini M, Occenae R, Manfreda J et al(1991). Long R. Pulmonary tuberculosis, human immunodeficiency virus type-1 and malnutrition. *Bull Int Union Tuberc Lung Dis,* 66:37–41.
 22. Schwenk, A., & Macallan, D. C. (2000). Tuberculosis, malnutrition and wasting. *Current opinion in clinical nutrition and metabolic care,* 3(4), 285–291. <https://doi.org/10.1097/00075197-200007000-00008>
 23. Yamanaka K, Sakai S, Nomura F (2001). Akashi T, Usui T. A nutritional investigation of homeless patients with tuberculosis. *Kekkaku,* 76:363–70.
 24. Semba RD, Darnton-Hill I, de Pee S (2010). Addressing tuberculosis in the context of malnutrition and HIV coinfection. *Food Nutr. Bull,* 31:S345-64. <https://doi.org/10.1177/15648265100314S404>
 25. Dargi B, Tesfaye G and Worku A (2016). Prevalence and associated factors of undernutrition among adult tuberculosis patients in some selected public health facilities of Addis Ababa, Ethiopia: a cross-sectional study. *BMC Nutrition,* 2:7. <https://doi.org/10.1186/s40795-016-0046-x>