

Undernutrition and associated factors among prisoners in Bahir Dar Zone Prison Center, Northwest Ethiopia, 2021

Gebyaw Lulie Adamu, Tadele Fentabil Anagaw, Genet Endalik Bishaw, Omer Seid Adem and Hunegnaw Almaw Derseh

Abstract

Purpose – This study aims to assess undernutrition and associated factors among prisoners in Bahir Dar Zone Prison Center, Ethiopia, in 2021.

Design/methodology/approach – An institution-based cross-sectional study was conducted among randomly selected 582 prisoners from October 1 to October 30, 2021. An interviewer-administered, semistructured questionnaire was used to collect the required data. The body mass index (BMI) was assessed to determine the nutritional status of prisoners. Data were entered into Epi-Info statistical software version 7 and exported to SPSS version 23 for analysis. Both bi-variable and multivariable logistic regression analyses were used to identify factors associated with undernutrition. In multivariable binary logistic regression analysis, variables with a p-value < 0.05 were considered significant. Adjusted odds ratios (AOR) and 95% confidence intervals (CIs) were used to measure the strength of the association.

Findings – The prevalence of undernutrition was 17.5% (95% CI: 14.3, 21). Imprisonment history (AOR: 4.98, 95% CI: 2.80, 8.86), history of cigarette smoking (AOR: 5.38, 95% CI: 2.86, 10.13), imprisonment duration (AOR: 1.82, 95% CI: 1.04, 3.19), diarrheal diseases (AOR: 1.98, 95% CI: 1.15, 3.41), depression (AOR: 3.23, 95% CI: 1.88, 5.57) and poor social support (AOR: 7.09, 95% CI: 3.57, 14.05) were factors significantly increasing the odds of undernutrition.

Originality/value – This manuscript is an original research article that was conducted by using primary data. The finding of the study implies that the magnitude of undernutrition among prisoners in the Bahir Dar Prison Center was found to be lower than the general population in Ethiopia. Therefore, this paper recommended behavioral change intervention, promotion of mental support and health education, cessation of cigarette smoking and management of diarrheal disease.

Keywords Undernutrition, Prison, Bahir Dar Prison Center, Ethiopia

Paper type Research paper

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Acronyms and Abbreviations

AIDS = acquired immuno deficiency syndrome;
AOR = adjust odd ratio;
BMI = body mass index;
EAR = estimated average requirements;
EDTA = ethylene diamine tetra acetic acid;
ICPR = Institute for Criminal Policy Research;
OSS-3 = Oslo-3 social support scale;
UDHR = Universal Declaration of Human Rights;
WHO = World Health Organization;
WPB = World Prison Briefs;
HTN = hypertension;
DM = diabetes mellitus; and
TB = tuberculosis.

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Introduction

According to the World Health Organization (WHO), malnutrition refers to deficiencies, excesses or imbalances in a person's intake of energy and/or nutrients. The term malnutrition addresses three broad groups of conditions: undernutrition, micronutrient-related malnutrition and overweight/obesity (WHO, 2024). Undernutrition denotes an insufficient intake of energy and nutrients to meet an individual's needs to maintain good health (National Library of Medicine NCFBI, 2006).

According to the Nelson Mandela Rules of Treatment of Prisoners are persons confined in prison after being convicted of crimes and are entitled, under the Due Process Clause of the Constitution, to be free from unauthorized and intentional deprivation of their personal property by prison officials (USLEGAL, 2022; UNODC, 2024). The basic rights of prisoners include the right to food and water, the right to have an attorney to defend themselves, and protection from torture, violence and racial harassment (Swathy, 2000/2022).

Adequate nutrition is a basic human right, and those in prison should be provided with healthy food choices to optimize their health (Leach and Goodwin, 2014). The quality and amount of food offered in a prison have a significant impact on a prisoner's quality of life; the supply of safe and nutritious food is vital to maintaining and improving the health of inmates and aiding in the prevention of diet-related diseases (Sultana *et al.*, 2015). Food provided must be adequate to maintain good health and nutrition, and it also must, if medically necessary, meet the needs of prisoners with conditions requiring special diets, such as diabetics and prisoners who have had heart attacks (Section JPL, 2024).

In prison settings, prisoners gain food from institutionally run catering services, self-cook facilities, prison shops or canteens and informal food preparation among inmates, which may take place despite institutional rules that prohibit such activities. It also includes opportunities for incarcerated people to cook and eat with their visitors and participate in garden or farming programs (Smoyer and Minke, 2015).

Encouraging prisoners to adopt good eating habits is a crucial component of prisons' efforts to improve health and welfare (WHO, 2019). Evidence suggests that the potential of food to enhance the prison environment and support improvements in prisoner health and wellbeing is limited when the nutritional content is inadequate and/or where food is served and eaten impacts negatively on human dignity (Woods-Brown *et al.*, 2023).

The prison is the main source of food for prisoners in Ethiopia. The quality and amount of food provided to prisoners in Ethiopian prisons are insufficient, and neither state nor federal laws nor policies specify any nutritional requirements. In all of the prisons, the main food is injera (local bread) and stew, which are mainly made with beans and contain no meat (Abera and Adane, 2017).

Prisoners may not eat for religious reasons, or if food is served that is not prepared following religious precepts, because of somatic problems such as dental problems, ulcers, obstructions of the digestive tract, because of mental disorders or anorexia nervosa. Most hunger-striker prisoners follow dietary fasts with the consumption of small amounts of food containing certain vitamins and trace minerals (Enggist *et al.*, 2014). However, a prolonged hunger strike poses a substantial risk of permanent damage to the nervous system (Başoğlu *et al.*, 2006).

In 2013, WHO and the United Nations Office on Drugs and Crime (UNODC, 2024) published a policy brief on the organization of prison health, with the main findings that states have a (1–26) special, sovereign duty of care for prisoners: they are accountable for all avoidable health impairments to prisoners caused by inadequate health care measures or inadequate prison conditions; and also prison health services should be integrated into national health policies and systems (WHO, 2013). Research showed that undernutrition among prisoners in Ethiopia ranges from 18.6% to 33.8% (Abera and Adane, 2017;

Yilma *et al.*, 2021; Wondimu *et al.*, 2021; Wondimu *et al.*, 2023; Melis, 2020). This is a significant public health problem among prisoners in Ethiopia.

Nutritional problems in prison can result in severe adverse outcomes and also increase the risk of developing acute and chronic nutritional deficiency diseases (Rachel *et al.*, 2018). Prisoners are at increased risk of undernutrition, and the consequences of undernutrition are significant, which include reduced muscle and tissue mass, decreased mobility and strength, an increased risk of chest infection and respiratory failure, delayed recovery from sickness, slower immune response, difficulty staying warm (hypothermia), poor libido and fertility problems; it also increases the rate of mortality (Leach and Goodwin, 2014; Rachel *et al.*, 2018; Times, 2009). Apart from the serious consequences for a person's health, undernutrition has an economic impact that hinders economic development and perpetuates poverty, both directly and indirectly, through lost productivity due to poor physical condition, poor cognitive function and learning deficits; furthermore, undernutrition raises health-care costs (Shekar *et al.*, 2006).

The living conditions in most prisons in the world are unhealthy due to conditions like overcrowding, violence, lack of light, fresh air and clean water, lack of food and infection-spreading activities such as tattooing, which are common. Also, rates of infection with TB, HIV/AIDS and hepatitis are much higher than in the general population (Fraser *et al.*, 2011). Prison conditions not only contribute to the risk of transmission but also hasten the progression of HIV and the deterioration of the health of prisoners living with HIV/AIDS (Daniel *et al.*, 2013).

The literature indicates that factors that lead prisoners to undernutrition include old age, male sex, history of previous incarceration and long duration of incarceration, lack of financial support, sleeping in groups, depression and taking two meals a day instead of three meals (Abera and Adane, 2017; Wondimu *et al.*, 2021; Yohannes, 2020; Ali, 2015; Mahato *et al.*, 2023).

The prison health system is inadequate in almost all developing countries, particularly in Sub-Saharan Africa (Kenea *et al.*, 2019), including Ethiopia (Melis, 2020) and the high prevalence of energy-depletion infectious diseases like pulmonary tuberculosis and HIV/AIDS lead to malnutrition (Shekar *et al.*, 2006; Ali, 2015).

The Ethiopian government has developed a National Nutrition Program (NNP) to provide optimal nutrition for all citizens, with special attention and priority given to vulnerable groups such as pregnant and lactating women, infants and under-five children, people living with HIV/AIDS, food insecure households, refugees, the elderly, prisoners and boarding school students (Health FMO, 2008). Some challenges faced in the implementation of NNP I are adolescent nutrition and lifestyle-related malnutrition initiatives, including communicable and noncommunicable diseases, which were not implemented or monitored and the existing structure is not strong enough to coordinate NNP implementation with clearly defined responsibilities and accountabilities (Ethiopia, 2016/2020). To address these challenges, the second NNP was developed with the main aim of maintaining the achievements of the first phase and addressing challenges that have focused on the life cycle approach, multisectoral integration and nutrition governance, but also have challenges of implementation that make it difficult to bring about effective change and achieve expected goals (Institute TEPH, NIPN, NIPN, 2020).

Ethiopia also recently developed a Food and Nutrition Policy in 2018, with the main objective of ensuring the availability, accessibility and utilization of diversified, safe and nutritious foods in a sustainable way for all citizens at all times (Ethiopia FDRo, 2018); despite this, prisoners in low-income countries like Ethiopia are often undernourished (Ali, 2015).

Nutritional problems are frequently neglected in low-income countries, particularly among vulnerable groups such as prisoners (Abera and Adane, 2017); in most cases, government

agencies and stakeholders give little attention and priority to the nutritional status of prisoners (Wondimu *et al.*, 2021). Previously, few studies were conducted in Ethiopia but focused on the nutritional status of prisoners with comorbidities such as HIV/AIDS and respiratory tract infection (Abera and Adane, 2017; Kassa *et al.*, 2017).

Therefore, this study assessed undernutrition and associated factors among prisoners in general and included variables such as the experience of diarrheal disease in the last two weeks, febrile illness in the last two weeks, respiratory illnesses in the last two weeks, the number of toilets and the availability of shower services, which were not included in the previous studies. This helps to assess the gap in the study area regarding undernutrition.

Methods and materials

Study setting, design and period

Bahir Dar Prison Center is one of the major prisons in the Amhara region. It is located in Sebatamit Kebele, which is 11 km from Bahir Dar city, behind Tibebe Ghion Specialized Hospital. It has one clinic, which contains two diplomas and two BSC nurses, one diploma and one BSC pharmacy, one diploma and one laboratory technician, one primary school (grades 1–8), one secondary school (grades 9–12), 24 teachers, 12 toilet houses and 12 shower rooms, 12 water pipes, 1 football sports field, 1 volleyball field and 1 cafeteria. Some volunteer prisoners participate in working as craftsmen, tillers and home vegetarians.

It accommodates thousands of inmates every year, and about 2,186 adult prisoners were incarcerated. From these male accounts, 2,136 and female = 50. The food menu of the prison has a weekly schedule, with breakfast containing 1 cup of tea and 200 g of bread, lunch containing Shiro Watt with injera and dinner containing Kik Watt with injera, with the exception of Miser Watt with injera on Wednesday and Sunday without snack foods. This meal schedule continues throughout the year except for holidays. An institutional cross-sectional study was conducted from October 1 to October 30, 2021.

Study population

All prisoners in the Bahir Dar Prison Center who were aged ≥ 18 years and stayed more than six months.

Inclusion and exclusion criteria

Inclusion criteria: all prisoners whose age was greater than ≥ 18 years and stay for at least six months.

Sample size and sampling procedures

The sample size was calculated using a single population formula by considering the following assumptions: a 95% confidence interval (CI), a marginal error of 4%, a proportion undernutrition of 38.8% (Ali, 2015) and a nonresponse rate of 5%. An average of 2186 prisoners were incarcerated per month; of those, about 1,864 stayed in prison for greater than or equal to six months (from the monthly registration of prisoners).

Using the single proportion formula:

$$\begin{aligned}n &= z^2 a / 2 p (1 - p) / d^2 \\&= (1.96)^2 (0.388) (0.612) / (0.04)^2 \\&= 571\end{aligned}$$

The final sample size = initial sample size + None response rate 5% = 571 + 29 = 600.

A simple random sampling technique was used to select the study participants, obtaining the lists of all prisoners from the prison records, then selecting the list of prisoners whose age is ≥ 18 years and who stayed six months and above in the prison, and giving ID to selected study populations. Finally, a computer-generated random number selection technique was used to select 600 study participants.

Study variables

Dependent variable: undernutrition (yes, no) Independent variables: socio-demographic characteristics; sanitation and institutional-related factors; behavioral and personal-related characteristics; work-related factors; and medical factors or types of self-reported illness.

Data collection tools and procedures Data were collected by using an interviewer-administered semi-structured questionnaire that included socio-demographic factors, institutional-related factors, behavioral-related factors, disease-related factors and work-related factors. The questionnaire was pretested on 5% of study participants who were incarcerated in Motta prison. Anthropometric measurements of participants were determined by recording the weight and height of individuals. Global physical activity questionnaire (GPAQ) was used to measure physical activity, OSSS-3 was used to assess the social support scale and PHQ-9 was used to measure depression level. OSSS-3 (Bøen *et al.*, 2012) and PHQ-9 (Kroenke *et al.*, 2001) were used and validated in the previous study in North Shao (Yohannes, 2020).

Physical activity The participant's physical activity was measured using an adaptation of the GPAQ that took into account both work and recreational activities. The activities were divided into two categories: moderate and intense intensity. Total time spent in physical activity during a typical week (i.e. duration of physical activity in minutes and frequency of physical activity per week) and intensity of physical activity were multiplied by four for moderate intensity and eight for intense intensity.

The total amount of activity was added up and divided into two categories: physically active (600+ MET minutes per week) and physically inactive (600 MET minutes per week). The ratio of a person's working metabolic rate to their resting metabolic rate is measured in METs. One MET is defined as the energy cost of sitting quietly and is equivalent to a caloric consumption of 1 kcal/kg/h (WHO, 2020).

Anthropometric measurements

The weight of the participants was measured using a mobile weight scale, and the height was measured using a tape meter. The weight scale was calibrated to zero before measuring each participant, and the accuracy of the instrument was checked by measuring the weight of a known object.

By measuring the height of an object with a known height, the accuracy of the stadiometer was also tested. Both measurements were taken wearing only light clothing, bare feet and without a hat. The weight was calculated to the nearest 0.1 kg.

When measuring height, the patient stood with his or her heels together and his or her weight evenly distributed. Patient positioning should be with the shoulder blades, buttocks and heels touching the vertical backboard or tape meter. They had their shoes off, feet together and arms by the sides, eyes looking straight ahead (Frankfurt plane) so that the line of sight was perpendicular to the body. When measuring body weight, the subjects stood still with their hands by their sides, their shoes removed and any unnecessary clothing removed. The values of height were recorded to the nearest 0.1 cm. Weight and height were measured twice, and an average of weight and height and body mass index

(BMI) [weight/height (kg/m^2) were computed. According to the guidelines, the best technique for determining a prisoner's nutritional status is to use the BMI ([Casadei and Kiel, 2020](#)).

Anthropometric measurement of a disabled person with spinal curvature We used arm span measurement to estimate the height of disabled persons with a curvature of the spine, weakness of back muscles or weakness in the leg muscles. We requested the participants to stretch out their arms, hands and fingers in a straight line and the measure requires two people:

- we asked the participant to remove any bulky clothing;
- we asked the participant to stand against a vertical surface, such as a wall or door frame, for support;
- we asked the participant to stretch out their arms, hands and fingers with their palms facing forward. Support can be given to maintain the arm position perpendicular to the body;
- we put the tape measure at the end of the middle finger on the right hand and held in place;
- the measurer should then stretch the tape across the body to the middle finger of the left hand;
- we checked the tape measure is horizontal to the floor;
- we recorded the measurement on the data entry form to the nearest 0.1 cm; and
- we measured the tip of the middle finger of the left hand.

Finally, height was estimated by using the formula: height in centimeters for males = $56.9 + (0.64 \times \text{arm span})$ and for women = $53.4 + (0.64 \times \text{arm span})$.

Then, by considering variations, BMI-in-arm span cut-offs are equivalent to BMI-ht cut-offs: for both males and females, BMI-ht cut-off measurement is $18.5 \text{ kg}/\text{m}^2$, but BMI-in-arm span cut-offs are different (i.e. for males, BMI cut-offs are $17.1 \text{ kg}/\text{m}^2$ and for females, $17.7 \text{ kg}/\text{m}^2$).

BMI in arm span for males $+1.4 \text{ kg}/\text{m}^2 = \text{BMI in height measurement}$.

BMI in arm span for females $+0.8 \text{ kg}/\text{m}^2 = \text{BMI in height measurement}$ ([De Lucia et al., 2002](#)).

Khat chewing: Participants were classified as chat chewers if they used chat for more than five years in their lifetime and chewed for more than four hours and over 100 g of khat per session. If they used chat for less than five years and chewed for less than 4 h and over 100 g of khat in a single chewing session, they were considered not chewers ([Legesse and Bedane, 2016](#)).

Cigarette smoking: participants who had smoked at least 100 cigarettes in their lifetime before they were incarcerated were classified as smokers and participants who had smoked < 100 cigarettes ever in their life were considered nonsmokers ([CDC, 2024](#)).

Alcohol consumption: An adult is considered a moderate drinker if they take in up to four drinks (one cup equals 25 mL for wine and Arieiki, one cup equals 125 mL for Tella and one small bottle or glass equals 330 mL for beer) each day or 14 drinks per week, measured in cups. Consider an adult to be a drinker if they consume more than four drinks of alcohol per day or more than 14 drinks per week ([USDA, 2015/2020](#)).

Social support: Based on the Oslo-3 Social Support Scale (OSS-3) respondents who have a score of 3–8 on the OSS-3 are considered to have poor social support; a score of 9–11 on

the OSS-3 is considered to have moderate social support; and scores of 12–14 on the OSS-3 are considered to have strong social support (Bøen *et al.*, 2012).

Depression: Depression was measured using the PHQ-9, which has nine items with a five-point severity scale over the last two weeks preceding the survey. Those who scored ≥ 10 were considered to have depression disorder (Kroenke *et al.*, 2001).

Data quality assurance

Data quality was ensured by translating the questionnaire from English to Amharic and then back-translated to English by language experts to maintain the consistency of the questions. A pre-test was administered to 5% of the study participants, Motta prison inmates. Based on the results of the pre-test, some modifications to items (such as wording and order of questions) were made. Three BSc nurse data collectors were trained for two days to ensure that everyone understood the purpose of the study, such as how to measure weight and height and how to approach each participant. Weight and height were measured twice and taken on average to decrease measurement error. The completeness, accuracy and consistency of the collected data were checked daily by the principal investigator. The measuring scales were regularly tested and calibrated before each measurement by using objects with known weight and height measurements.

Data processing and analysis

Data were cleaned, coded and entered into Epi-Info statistical software version 7 and exported to SPSS version 23 for further analysis. To assess the undernutrition of the study subject, anthropometric data were converted to BMI and compared to the standard reference. Descriptive statistics were presented with graphs and tables. The relationship between the dependent and independent variables was investigated using an odds ratio with 95% confidence. A binary logistic regression was used to analyze the association between the outcome variable (undernutrition) and the independent variables. Bi-variable logistic regression analysis was performed to estimate the relative contribution of each variable to the outcome variable, while multivariable logistic regression analysis was used to determine the effect of several factors on the outcome variable. Data from bi-variable analysis with a p -value of less than 0.25 were candidate variables to enter multivariable analysis; those variables with a p -value of less than 0.05 in the multivariable analysis were considered significant factors in undernutrition. Multicollinearity was checked by checking the variance inflation factor ($p = 1.02$). Hosmer–Lemeshow The goodness-of test ($p = 0.78$) was used to check the fitness of the model to determine whether it adequately describes the data.

Results

Socio-demographic characteristics of the respondents

From the total sample of 600 prison inmates, 582 were interviewed in the study, which is a response rate of 97%. The mean $\pm$ SD of the participant's age was 34.6 (± 10.169) years, and his age ranges from 18 to 65 years. More than half of the participants (313, or 53.8%) were living in prison for a duration of ≥ 12 months (Table 1).

Sanitation and institutional characteristics of prisoners Out of the total respondents, about 16 (2.7%) respondents were not washing their hands before eating and 17 (2.9%) participants did not practice washing their hands after defecation. About 158 (27.1%) of prisoners were taking showers < 2 times per week (Table 2).

Behavioral characteristics of prisoners Of the total respondents, 76 (13.1%) were cigarette smokers before being incarcerated, 72 (12.4%) had a history of chewing khat and 375 (64.4%) were alcohol users. More than half of 305 (52.4%) had physical inactivity (Table 3).

Table 1 Socio-demographic characteristics of a prisoner in Bahir Dar Prison Center, North West Ethiopia, 2021			
<i>Variable</i>	<i>Category</i>	<i>Frequency</i>	<i>%</i>
Age	<=19	8	1.4
	20–24	78	13.4
	25–29	137	23.5
	30–34	110	18.9
	35–39	81	13.9
	40–44	60	10.3
	45–49	35	6
	>50	73	12.5
Sex	Male	543	93.3
	Female	39	6.7
Educational status	Unable to read and write	107	18.4
	Able to read and write	108	18.6
	Primary (grade 1–8)	121	20.8
	Secondary (grade 9–12)	110	18.9
	College and above	136	23.4
Marital status	Single	247	42.4
	Married	268	46
	Divorced	53	9.1
	Widowed	14	2.4
Religion	Orthodox	498	85.6
	Muslim	51	8.8
	Protestant	30	5.2
	Catholic	3	0.5
Residence	Urban	262	45
	Rural	320	55
Occupation before imprisonment	Farmer	213	36.6
	Merchant	99	17
	Civil servant	72	12.4
	Student	107	18.4
	Others	91	15.6
Duration of imprisonment	< 12 month	269	46.2
	>= 12 month	313	53.8
History of imprisonment	Have a history of imprisonment	122	21
	Have no Hx of imprisonment	460	79
Social support	Poor social support	323	55.5
	Moderate social support	137	23.5
	Strong social support	122	21
Financial support	Yes	189	32.5
	No	393	67.5
Notes: N= 582; Others – Driver, Daily laborer			
Source: Table by authors			

Morbidity-related characteristics More than one-sixth 105 (18%) of the participants had chronic diseases such as DM, HTN, HIV/AIDS and TB. Of the total participants, 249 (42.8%), 178 (30.6%) and 153 (26.3%) had a respiratory illness, diarrheal disease or febrile illness in the past two weeks, respectively and nearly half of the respondents, 280 (48.1%), had depression ([Table 4](#)).

Work-related characteristics of prisoners in the Bahir Dar Zone prison center Out of the total respondents, only 160 (27.5%) had a job in prison. Among the total participants, 40 (6.9%) were tillers, 49 (8.4%) were craftsmen and 71 (12.2%) were doing other jobs (waiters in the cafeteria and tillers of traditional clothes).

The prevalence of undernutrition and factors associated with undernutrition among prisoners In this study, the prevalence of undernutrition was 17.5% (95% CI: 14.3, 21). The bi-variable analysis result showed that imprisonment history, duration of imprisonment,

Table 2 Sanitation and institutional characteristics of prison inmates in Bahir Dar Prison, North West Ethiopia, 2021

Variable	Characteristics			Frequency	%
Time of washing hands	Wash hands before eating			566	97.3
	Not wash hands before eating			16	2.7
	Wash hands after eating			564	96.9
	Not wash hands after eating			16	3.1
	Wash hands after defecation			565	97.1
	Not wash hands after defecation			17	2.9
Shower frequency/week	>=2 times/week			424	72.9
	<2 times/week			158	27.1
Type of dormitory	No- of class	Area of a single dormitory	No-of window for each dormitory	Average no-of prisoners in each dormitory	Average no-of prisoners share a toilet
Larger class/dormitory	44	30m*6m = 180m ²	30	58	28
Small dormitory	18	3m*3m = 9m ²	1	2	

Note: N = 582

Source: Table by authors

Table 3 Behavioral characteristics of prisoners incarcerated in Bahir Dar Zone Prison Center, North West Ethiopia, 2021

Variables	Characteristics	Frequency	%
Smoking status	Nonsmoker	506	86.9
	Smoker	76	13.1
No cigarette smoked/lifetime	<100 cigarette/life time	40	6.9
	>=100 cigarette/life time	36	6.2
Alcohol drinking status	Nondrinker	207	35.6
	Drinker	375	64.4
Amount of alcohol drunk	<=14 drinks/week	267	45.9
	>14 drinks/week	108	18.6
Chewing status	No	510	87.6
	Yes	72	12.4
Hours spent on khat chewing on a single occasion	<=4 h	68	11.7
	>4 h	4	0.7
Years elapsed on khat chewing	<=5 years	21	3.6
	>5 years	51	8.8
Amount of chewed khat per session	<100 g	18	3.1
	>100 g	54	9.3
Physical activity	Physical inactive	305	52.4
	Physical active	277	47.6

Note: N = 582

Source: Table by authors

history of smoking, chronic diseases, experience of respiratory diseases in the past two weeks, experience of diarrheal diseases in the past two weeks, depression, social support and physical activities were significant factors with undernutrition at $p < 0.25$.

The multivariable logistic regression analysis revealed that previous history of imprisonment, duration of imprisonment, history of smoking, experience of diarrheal diseases, social support and depression were significantly associated with undernutrition at $p < 0.05$.

This study revealed that respondents who had previous imprisonment history were five times more likely to be undernourished [adjusted odds ratios (AOR): 4.98, 95% CI: 2.80, 8.86] than prisoners who had no previous imprisonment history.

Table 4 Morbidity-related characteristics among the respondents Bahir Dar Prison, North West Ethiopia, 2021

<i>Variables</i>	<i>Response</i>	<i>Frequency</i>	<i>%</i>
Chronic diseases	No	477	82
	Yes	105	18
Type of chronic diseases	Diabetes mellitus	31	5.3
	Hypertension	20	3.4
	HIV/AIDS	25	4.2
	Tuberculosis	11	1.9
	Other chronic disease ^a	19	3.3
Respiratory illness in the past 2 weeks	No	333	57.2
	Yes	249	42.8
Type of respiratory illness in the past 2 weeks	Common cold	153	26.3
	Asthma	45	7.7
	Pneumonia	35	6
	Other respiratory illness ^b	19	3.3
Diarrheal diseases	No	404	69.4
	Yes	178	30.6
Type of diarrheal disease in the past 2 weeks.	Giardia	82	14.1
	Amebia	61	10.5
	Other ^c	12	2.1
Febrile illness	No	429	73.7
	Yes	153	26.3
Type of febrile illness in the past 2 weeks	Malaria	31	5.3
	Typhoid	29	5
	Other ^d	14	2.4
Depression	Not depressed	302	51.9
	Depressed	280	48.1

Notes: N= 582; ^aKidney stone, liver disease, bile stone; ^bSinusitis; ^cHook worm; ^dTyphus
Source: Table by authors

Participants who stayed in prison ≥ 12 months were 1.82 times more likely to be undernourished (AOR: 1.82, 95% CI: 1.04–3.19) compared to those participants imprisoned less than 12 months.

Participants who had a smoking history were more than five times more likely to be undernourished (AOR: 5.38, 95% CI: 2.86–10.13) than nonsmokers. Prisoners who had diarrheal diseases were two times more likely to be undernourished (AOR: 1.98, 95% CI: 1.15, 3.41) compared to those prisoners who did not experience diarrheal diseases in the past two weeks. Prisoners who had depression in the past two weeks had more than three times to be undernourished (AOR: 3.23, 95% CI: 1.888, 5.57), compared to prisoners who had not depression. Prisoners who had poor social support were seven times more likely to be undernourished (AOR: 7.09, 95% CI: 3.57, 14.05) than those who had strong social support (Table 5).

Discussion

This study aimed to assess undernutrition and associated factors among prisoners. According to this study, the prevalence of undernutrition was 17.5%, which is lower than the general population in Ethiopia, which was 33% (EDHS 2016 report). The prevalence of this study was in line with the findings of the studies in Mizan Tepi and North Shoa (Wondimu *et al.*, 2021; Yohannes, 2020). This might be due to the relative similarity of the socio-economic and health status of the population.

The prevalence of this study was lower than the findings of the study in the Gondar prison center (Ali, 2015). This might be due to differences in the source population (i.e. male

Table 5 Bi-variable and multivariable analysis of factors associated with undernutrition among prisoners incarcerated in Bahir Dar Zone Prison Center, northwest Ethiopia, 2021

Variables	Categories	Undernutrition		COR (95% CI)	AOR (95% CI)
		Yes	No		
Imprisonment Hx	Yes	43	79	3.70 (2.33–5.87)	4.98 (2.80, 8.86)*
	No	59	401	1	1
Duration of imprisonment	≥12 month	67	246	1.82 (1.17–2.85)	1.82 (1.04, 3.19)*
	<12 month	35	234	1	1
Smoking	Yes	38	38	6.90 (4.10–11.62)	5.38 (2.86, 10.13)*
	No	64	442	1	1
Chronic diseases status	Yes	23	82	1.41 (0.84–2.38)	0.83 (0.42, 1.63)
	No	79	398	1	1
Respiratory illness	Yes	57	192	1.90 (1.23–2.92)	1.32 (0.77, 2.27)
	No	45	288	1	1
Diarrheal diseases	Yes	47	131	2.277 (1.47–3.53)	1.98 (1.15, 3.41)*
	No	55	349	1	1
Social support	Poor	22	301	5.50 (3.07–9.87)	7.09 (3.57, 14.05)*
	Moderate	45	92	0.82 (0.48–1.40)	0.82 (0.44, 1.54)
	Strong	35	87	1	1
Physical activity	Good physical activity	58	219	1.57(1.02–2.42)	1.06 (0.62, 1.83)
	Poor physical activity	44	261	1	1
Depression	Depressed	69	211	2.67(1.70–4.19)	3.23(1.88, 5.57)*
	Not depressed	33	269	1	1

Notes: AOR: adjusted odds ratio; COR: crude odds ratio. *N* = 582; **p*-value <0.05; Used – Enter method

Source: Table by authors

prisoners). Male prisoners are involved in strenuous activities like steel work and woodwork but may not get enough food to meet their body requirements.

This study's prevalence of undernutrition is also lower than the findings of the study in Madagascar ([Ravaoarisoa et al., 2019](#)). The variation in study participants' gender in Madagascar could be the cause of the variance. It was added that the difference might result from women's bodies being smaller and less muscular than men's and that women are more likely to suffer from undernutrition because of the higher nutritional requirements brought on by menstruation, pregnancy and lactation ([Environment Agency Wales, 2020](#)).

The prevalence of undernutrition in this study was higher than in studies conducted in Tanzania and Nigeria ([Akinlotan et al., 2010](#); [Gould et al., 2013](#)). This discrepancy may be due to the difference in socioeconomic status in the study areas, i.e. both Tanzania and Nigeria have relatively better statuses. Additionally, in terms of health services, the most vulnerable populations in Nigeria benefit from free health-care services and exemption mechanisms, and in Tanzania, provisions for exemptions and waivers within the cost recovery program were introduced to protect vulnerable social groups and the very poor ([Mamdani and Bangser, 2004](#); [Aregbeshola, 2019](#)). Further explanation: the discrepancy may be due to a difference in sample size.

The findings of this study reflected that the odds of being undernourished among prisoners who had previously been in prison were nearly five times higher than prisoners who had not been. The finding is also supported by another study conducted in Mizan Tepi, which states that imprisonment history was a factor that significantly increased the risk of undernutrition ([Wondimu et al., 2021](#)). This may be due to the similarity of the source population and study group. Another reason might be that the employment rate and earnings of individuals released from prison are low and have an increased probability of undernutrition ([Holzer and Raphael, 2003](#)). This implies that being in prison is an exposure to the development of undernutrition.

The result of this study showed that prisoners who stayed ≥ 12 months were two times more likely to be undernourished than prisoners who stayed less than 12 months. This finding was supported by another study conducted in Mizan, which states that longer duration of imprisonment was a factor that significantly increased the risk of under-nutrition (Wondimu *et al.*, 2021). This might be due to the fact that incarcerated prisoners for longer periods expose them to poor nutrition, both in quantity and quality, which leads to undernutrition.

The findings of the study revealed that cigarette smokers before incarceration were five times more likely to be undernourished than nonsmokers before being imprisoned. This finding is supported by a study done in Pakistan (Qadir *et al.*, 2017). This might be due to the fact that cigarette smoking decreases the immune system and increases the risk of acquiring chronic diseases like heart disease, lung disease, COPD, stroke, certain eye diseases and others. This may lead to poor appetite and weak immunity, which may increase undernutrition.

This study showed that prisoners who had poor social support had nearly eight times an increase in the odds of undernutrition than those who had good social support. This study was comparable to the result obtained from North Showa (Yohannes, 2020). This might be due to the fact that those people who are not supported by close relationships with friends, family or fellow members of the church, work or other support groups in terms of emotional support, physical support such as money and materials and informational support are more vulnerable to ill health and undernutrition (University of Minnesota, 2016).

Participants who had depression were three times more likely to be undernourished than those who had no depression. This result is similar to the study findings in Bahir Dar, Mizan Tepi and North Shoa (Wondimu *et al.*, 2021; Yohannes, 2020; Alemayehu *et al.*, 2019). This might be due to the corticotropin-releasing hormone (CRH) being released from the hypothalamus in response to the perception of psychological stress by cortical brain regions. This hormone induces the secretion of pituitary corticotropin, which stimulates the adrenal gland to release cortisol into the plasma. The high production of cortisol can lead to inflammation, insulin resistance, poor cardiovascular function and impaired immunity that decreases nutritional status (Hasler, 2010). Another explanation for this could be that depression is associated with major symptoms such as increased sadness and anxiety, loss of appetite, skipping meals and a loss of interest in pleasurable activities (Rao *et al.*, 2008).

Prisoners who had diarrheal diseases were two times more likely to be undernourished than those who did not have diarrheal diseases. This finding was similar to a study done in Myanmar (Abegaz, 2019). This finding may be because diarrhea can lose a lot of body fluid and also be accompanied by symptoms such as nausea or loss of appetite, vomiting and abdominal pain; which also makes it hard to keep food and liquids down. This reduces your calorie intake, which can also contribute to weight loss (Pratt, 2022).

This study finding implies that each responsible body should work on behavioral change intervention, promotion of mental support, health education for the cessation of cigarette smoking and managing diarrheal disease to the consequences of undernutrition among prisoners. It is also recommended to do further research by using quantitative dietary assessment methods to determine the exact nutrient intake level among prisoners.

Limitations and strengths: The strength of this study is that it includes participants with leg deformities and spinal curvature/kyphosis who were not included in previous studies. However, because the data is cross-sectional, it is not possible to draw conclusions about the direction of relationships between research variables.

Conclusion

The magnitude of undernutrition among prisoners in the Bahir Dar Prison Center was found to be lower than the general population in Ethiopia. Factors associated with undernutrition were imprisonment history, smoking status, diarrheal diseases, depression, social support and duration of imprisonment. Therefore, we recommended behavioral change intervention, promotion of mental support and health education for the cessation of cigarette smoking and managing diarrheal disease.

Declarations

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Ethical considerations: Ethical clearance was obtained from the Ethical Review Board of Bahir Dar University College of Medicine and Health Sciences. A written letter for the next steps was adopted from the Bahir Dar prison administration office. Consent was obtained from each study participant after informing them of all the purposes, benefits, risks, and their right to refuse or discontinue participation at any point during data collection, as well as the confidentiality of the information and the voluntary nature of the participation in the study. The names of the participants were not collected. Each participant was informed in advance that their participation would not be considered in decisions regarding his or her release or future detention. Participation is completely voluntary, with no economic or other motivational incentive, and written informed consent was obtained from each participant. The possible prevention methods for Corona Virus Disease 19 (COVID-19) were implemented during data collection.

Conflict of interest: All authors declared that have no conflict of interest.

Contribution of authors: GL, OS, and HAD participated in the design, collection, analysis, and interpretation of the data. HAD, and TFA drafted the manuscript. GL, OS, HAD, TFA, and GE critically reviewed the manuscript and contributed more to writing the manuscript. All authors read and approved the final manuscript.

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