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EDITORIAL

Vitamin D and immunity : reality or phantasy?

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A PubMed search using the terms “vitamin D and immunity” reveals more than 6,000 papers. While a PubMed search using the terms “vitamin D and COVID-19” results in more than 1,000 paper with both showing an increasing trend of publications. What’s these indicates to us? Vitamin D has been attracting a lot of attention from researchers, pharmaceutical industries and public mainly because of its potential extra-skeletal effects in health and in various diseases such as diabetes, cardiovascular diseases, cancer and autoimmune diseases. Historically, vitamin D was associated with diseases such as rickets in children and osteoporosis is adults. However, during the COVID-19 pandemic, vitamin D gained a special focus related to its immune modulating ability. Previously, vitamin D is reported to help in boosting the immune system via several mechanisms.[1–3] With regards to viral infection such as COVID-19, vitamin D enhances cellular immunity by reducing the cytokine storm by reducing the expression of pro-inflammatory cytokines and increasing the expression of anti-inflammatory cytokines. A detailed mechanistic and therapeutic insights is discussed by Marcinkowska and Brown (2022). Unfortunately, vitamin D or the sunshine vitamin is surprisingly lacking in people in the Asian region and across all age groups.[1,5,10,11] This is mainly due to limited intake of vitamin D rich food source in this region and due to sun ray avoidance behaviour[4] and monsoon season.[8] Obesity further exacerbates deficiency as the fat-soluble vitamin D is sequestered and stored in adipose tissue instead of blood circulation.[12]

COVID-19 is a wakeup call for everyone to rethink on the importance of ensuring adequate intake of vitamin D in their daily diet and the importance of maintaining healthy body weight. It is also an urgent reminder to researcher to explore more on this topic as data and publications on this area is lacking particularly in the Asian region.

Keywords: congenital heart disease, malnutrition, surgery

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ORIGINAL PAPER

Vitamin D serum level as a prognostic factor in predicting mortality of severe COVID-19 patients: An evidence based case report

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Abstract

Introduction: The mortality rate of COVID-19 is still high. Many prognostic factors have been studied to decrease the mortality rate. One of the many factors is vitamin D status, known for years as an immunomodulator and anti-inflammatory agent. Vitamin D deficiency could worsen the symptoms of COVID-19 and ultimately lead to mortality. However, some literature shows controversial results.

Methods: Literature research was conducted by advanced searching in Pubmed, Cochrane Library, Scopus, and ProQuest, using a combination of both MeSH Terms and Title/Abstract. After removing duplicates, these literature were screened according to the eligibility criteria. Appraisal and level of evidence of the final literature were determined based on Oxford Centre for Evidence-Based Medicine.

Results: Three selected literature were relevant to answer our clinical question. The first literature is a retrospective cohort study by Radujkovic et al. while the other two are prospective cohort studies by Bennouar et al. and Campi et al. All literatures show similar results that low vitamin D serum levels in severe COVID-19 patients can increase the in-hospital mortality risk.

Conclusion: Vitamin D is one of the prognostic factors that can predict the mortality rate of severe COVID-19 patients. We suggest that vitamin D serum level can be measured regularly in COVID-19 patients and administered to patients with such deficiencies. Adequate vitamin D deficiency management is expected to lower the COVID-19 mortality rate.

Keywords: COVID-19, SARS-CoV-2, vitamin D, 25-hydroxyvitamin-D, mortality, prognosis

Case Scenario

A 57-year-old man was admitted to the emergency department due to breathing difficulty since 3 days prior. The symptoms were worsened while doing activities and not relieved by rest. The patient also reported a dry cough. He did not have any history of chronic illnesses, except chronic obstructive pulmonary disease and recurrent pulmonary tuberculosis since 2011. The patient stated that he had never made any contact with COVID-19 patients, but recently, one of his neighbors tested positive for COVID-19. He regularly visited the hospital nearby to control his pulmonary condition.

Lung physical examination was remarkable for rhonchi at both lungs, with minimal vesicular sounds at the bases. Chest X-ray revealed a suspicion for tuberculosis infiltrate. He tested negative for GeneExpert MTB but positive for the nasopharyngeal SARS COV-2 RT-PCR swab. The patient was admitted to the intensive care unit, and as the condition deteriorated, he fell into a condition that required mechanical intubation. The patient was then consulted to a clinical nutrition physician to

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monitor his nutritional intake. Based on the anthropometric measurement, the patient's body mass index was 22.2 kg/m^2. The patient received liquid nutritional treatment and vitamin D 2x1000 IU. One of the patient's family members asked whether vitamin D deficiency can threaten the patient's condition.

Introduction

Based on WHO data in March 2021, it was reported that COVID-19 confirmed cases worldwide had exceeded 125 million cases with 2.7 million deaths, including Indonesia itself, which had more than 1 million confirmed cases and 40 thousand deaths. These data were considerably high in Asian countries.[1] COVID-19 has various clinical manifestations, ranging from asymptomatic to severe symptoms. A few risk factors had been known to worsen the COVID-19 infection, including older age, chronic illnesses such as hypertension, diabetes mellitus, obesity, and other cardiovascular or respiratory comorbidities.[2]

Vitamin D has been extensively studied in the last decade. Vitamin D deficiency is commonly found in chronic illnesses, such as obesity, diabetes mellitus, hypertension, and systemic infections.[2,3] Vitamin D has been known to have a significant role in the immune system as an immunomodulatory agent, which can increase innate immune response in the respiratory tract mucosal. Moreover, vitamin D is also vital in stimulating antimicrobial peptides that can reduce virus replication.[4]

A study by Radujkovic et al.[5] showed that among 185 COVID-19 patients, 22% of patients had vitamin D serum levels below 12 ng/mL. Some studies also showed that people with low 25(OH)Vitamin D serum have poorer clinical outcomes than those with normal vitamin D levels. A study conducted in Turkey showed a mean difference in patients with moderate and severe stage of COVID-19 26.3 ± 8.4 vs 10.1 ± 6.2, $p < 0.001$, respectively.[6,7] There was also a mean difference in vitamin D level in COVID-19 patients who survived, 19.3 ± 11.2 vs died 10.4 ± 6.4, $p < 0.001$.[7] Vitamin D supplementation can decrease pro-inflammatory cytokines, such as TNF-α, interferon-γ, and IL-6, while increasing inhibitory cytokines.[8,9] Adequate vitamin D level has been expected to lower the incidence of cytokine storm, which is generally found in severe COVID-19 patients and a cause of death in COVID-19.[9]

Other factors are also likely to affect the severity of COVID-19, such as respiratory and cardiovascular disorders, obesity, and hypertension, which are also related to vitamin D deficiency. Therefore, the association between vitamin D and COVID-19 is unclear.[10,11] Some studies regarding the association between vitamin D levels and COVID-19 patients' mortality also showed mixed results. A study in Saudi Arabia showed that 74.7% of COVID-19 patients also experience vitamin D deficiency and have 7 times higher mortality incidents [HR 7.0 (CI 1.7-28.20; p=0.007].[12] Another study performed by Lohia et al.[4] showed that there was no significant association between vitamin D serum levels and mortality, ventilator utilization, and thromboembolic incidents in COVID-19. Based upon these controversial results, it is essential to perform further investigations to determine the relationship between vitamin D serum level and COVID-19 patients' mortality incidence, which will be discussed in this evidence based case report.

Indonesia's population is known to have a high vitamin D deficiency incidence. One of the studies investigating vitamin D levels among elderly women in 4 main hospitals in Jakarta and Bekasi showed a 35.1% prevalence of vitamin D deficiency.[13] This high vitamin D deficiency prevalence was suggested to affect the mortality of COVID-19 patients in Indonesia.

Clinical Question

"In adult patients with severe COVID-19, could vitamin D serum level affect the patient's mortality?"

P : Adult patients with severe COVID-19
I : Vitamin D serum level
C : -
O : Mortality

Methods

Literature searching was conducted by advanced searching using combination of both MesH Terms

and Title/Abstract in four databases, Pubmed, Cochrane Library, Scopus, and ProQuest. Keywords that were used include *"COVID-19", "SARS-CoV-2", "Vitamin D", "25 Hydroxyvitamin D", "Mortality",* and *"Death".* Authors used Oxford Centre for Evidence-Based Medicine as a guide to critically appraise the literature and determine the level of evidence.

Eligibility Criteria

Inclusion criteria

1. Patients aged 18-65 years old with severe COVID-19 diagnosis.
2. Vitamin D serum level was assessed during the patients' hospitalization.
3. The study output was COVID-19 patients' mortality.
4. Cohort studies, survival studies, or systematic review/meta-analysis of cohort or survival studies.
5. Articles were published in English.

Exclusion criteria

1. Studies were not conducted on humans.
2. The published article was not available in full text.

Results

The authors found 176 literatures from Pubmed database, 30 literatures from Cochrane Library, 106 literatures from Scopus and 23 literatures from ProQuest. Duplicates removal was done using Covidence application (Table 1). Lastly, literatures were assessed for eligibility based on PICO and eligibility criteria. (Figure 1) We finally selected 3 articles from Radujkovic et al.[5], Bennouar et al.[14], and Campi et al.[15] The level of evidence of these articles is 2 (Table 2). All of the articles were valid and relevant to answer our clinical question. (Table 3, Table 4)

Discussion

COVID-19 mortality continues to increase. Various prognostic factors have been studied to reduce COVID-19 mortality, including vitamin D levels. From the literature search, three studies by Radujkovic et al.[5], Bennouar et al.[14], and Campi et al.[15] showed similar results that vitamin D level is an important prognostic factor in estimating mortality in severe COVID-19.

The study by Radujkovic et al.[5] found that vitamin D deficiency was associated with a higher incidence of in-hospital death, both in the entire cohort (HR 14.73, CI 95% [4.16-52.9], $p < 0.001$) and in the inpatient group (HR 11.51, CI 95% [3.24-40.92]). The vitamin D deficiency group was also at a higher risk for mechanical ventilation, both in the entire cohort (HR 6.12, CI 95% [2.79-13.42], $p < 0.001$) and inpatient group (HR 4.65, CI 95% [2.11-10.25], $p < 0.001$). Bennouar et al.[14] also found that only the severe vitamin D deficiency group had a significant association with an increased risk of mortality (HR=6.9, 95% CI [2.0-24.1], p=0.002). Severe vitamin D deficiency also significantly reduced the survival rate ($P_{log\text{-}rank}$=0.009). Campi et al.[15] found that severely-symptomatic COVID-19 patients had lower vitamin D levels (18.2 ± 11.4 ng/mL) than mildly-symptomatic and non COVID-infected controls (30.3 ± 8.5 ng/mL and 25.4 ± 9.4 ng/mL, $p < 0.0001$). This study also showed that vitamin D deficiency is more common in group of patients requiring ICU admission than in those who did not. In addition, vitamin D levels was inversely correlated with in hospital mortality in severely-symtpomatic COVID-19 patients [RR 0.961, CI 95% (0.937 – 0.985, p value = 0.002]. A 1 ng/mL increase in 25(OH)D levels was associated with a reduction of 1% of ICU admission risk (95% CI 0 to 2%, p value = 0.011).

Although the confidence interval is quite wide due to the small number of samples, the results of these studies are in line with several previous studies examining the relationship between vitamin D and COVID-19. Several studies have suggested that vitamin D deficiency is associated with poor prognosis in COVID-19 patients. Recent studies have shown that many patients with severe COVID-19 have vitamin deficiency on admission.[4,7]

Table 1. Literature searching strategy

Database	Search Strategy	Hits	Selected article
Pubmed	(("covid 19"[MeSH Terms] OR "covid 19"[Title/Abstract] OR ("sars cov 2"[MeSH Terms] OR "sars cov 2"[Title/Abstract])) AND ("vitamin d"[MeSH Terms] OR "ergocalciferols"[MeSH Terms] OR "vitamin d"[Title/Abstract] OR ("calcifediol"[MeSH Terms] OR "25 hydroxyvitamin d"[Title/Abstract])) AND ("mortality"[MeSH Terms] OR "mortal*"[Title/Abstract] OR ("Death"[MeSH Terms] OR "Death"[Title/Abstract])))	176	20
Cochrane Library	#1 MeSH descriptor: [COVID-19] explode all trees #2 ("COVID 19"):ti,ab,kw #3 ("SARS COV 2"):ti,ab,kw #4 MeSH descriptor: [Vitamin D] explode all trees #5 ("vitamin D"):ti,ab,kw #6 ("25-hydroxy vitamin D"):ti,ab,kw #7 MeSH descriptor: [Mortality] explode all trees #8 (MORTALITY):ti,ab,kw #9 (DEATH):ti,ab,kw #10 MeSH descriptor: [Death] explode all trees #11 #1 OR #2 OR #3 #12 #4 OR #5 OR #6 #13 #7 OR #8 OR #9 OR #10 #14 #11 AND #12 AND #13	30	0
Scopus	*((TITLE-ABS-KEY ("COVID 19") OR TITLE-ABS-KEY ("SARS COV 2"))) AND ((TITLE-ABS-KEY ("VITAMIN D") OR TITLE-ABS-KEY ("25 HYDROXYVITAMIN D"))) AND ((TITLE-ABS-KEY (mortality) OR TITLE-ABS-KEY (death))) AND (LIMIT-TO (SUBJAREA , "MEDI")) AND (LIMIT-TO (DOCTYPE , "ar"))*	106	6
ProQuest	(ti(COVID 19) OR ti(SARS COV 2)) AND (ti(VITAMIN D) OR ti(25 HYDROXYVITAMIN D)) AND (ti(MORTALITY) OR ti(DEATH))	23	2

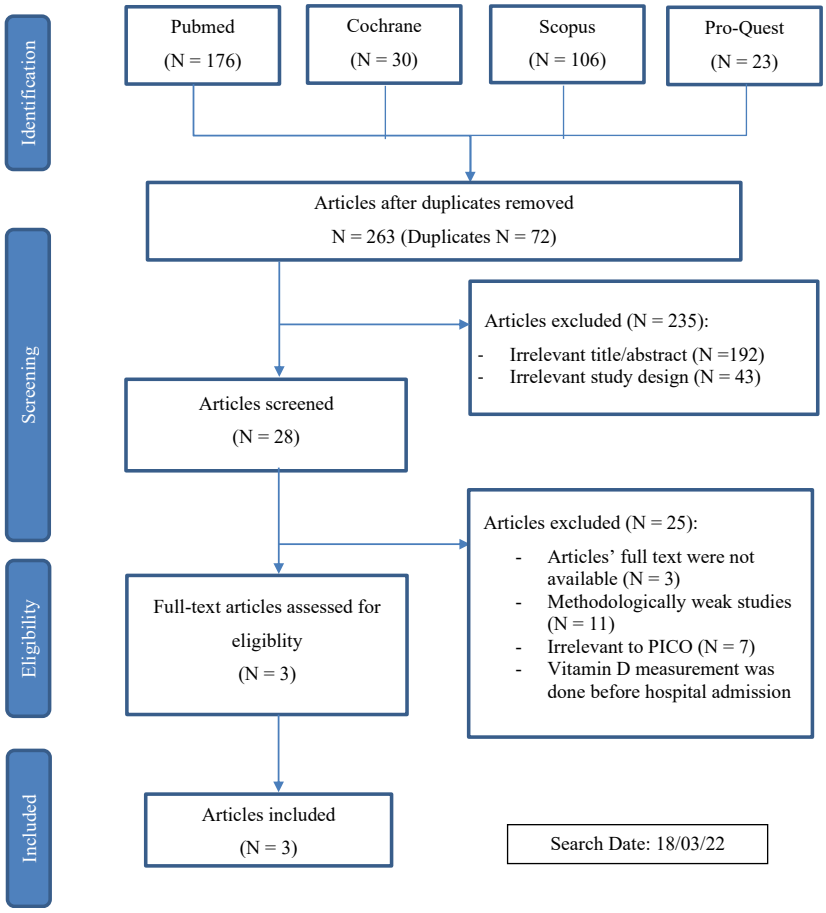

Figure 1. Prisma's flow chart

Tabel 2. Study charactheristic

Articles	Study design	Population	Outcome
Radujkovic, et al, (2020)[5]	Retrospective cohort study	185 patients, >18 years old diagnosed with COVID-19, had been tested for vitamin D levels on admission. Patients were divided into subgroups: mild symptoms (outpatient) and severe (inpatients). Based on vitamin D levels, patients were classified into: Deficiency (<12ng/mL), control (≥12 ng/mL)	Mortality rate and the use of an invasive mechanical ventilator
Bennouar et al, (2020)[14]	Prospective cohort study	120 patients, >18 years old diagnosed with severe COVID-19, had been tested for vitamin D levels on admission. Based on vitamin D level, patients were classified into: Optimal (>78 nmol/ l or >10 μg/l), insuffiency (52-75 nmol/l or 20-29 μg/l), deficiency (26-52 nmol/l or 10-20 μg/l) and severe (< 26 nmol/l or < 10 μg/l)	In-hospital mortality within 28 days of admission

Tabel 2. Study charactheristic

Articles	Study design	Population	Outcome
Campi et al. (2021)[15]	Prospective cohort study	361 patients, >18 years old diagnosed with COVID-19, had been tested for vitamin D levels. Patients were divided into subgroups: mildly symptomatic, severely symptomatic and non SARS-CoV-2 infected controls . Based on vitamin D levels, patients were classified into: Deficiency (≤12ng/mL), control (>12 ng/mL)	The need of admission to ICU and in-hospital mortality

Table 3. Validity criteria

Relevance										
Article	Common point	Follow up	Outcome	Adjustment	Outcome over time	Precision	Applicability	Clinically important	Result	Level of Evidence
Radujkovic, et al.[5]	+	+	+	+	+	+	+	+	A	2
Bennouar, et al.[14]	+	+	+	+	+	+	+	+	B	2
Campi, et al.[15]	+	+	+	+	+	+	+	+	C	2

A: inpatient with vitamin D deficiency group had a significantly higher mortality rate (HR = 11.51, CI 95% [3.24-40.92], p<0.001).
B: inpatient with severe vitamin D deficiency group had a significantly higher mortality rate than the vitamin D deficiency and insufficiency groups (HR = 6.9, 95% CI [2.0-24.1], p=0.002). Patients with severe vitamin D deficiency had a significantly reduced likelihood of survival ($P_{log\text{-}rank}$=0.009)
C: vitamin D levels inversely correlated with mortality rate (RR 0.97, 95% CI [0.95-0.99], p=0,011)

Table 4. Relevance criteria

1.	Similarity Population	Similarity Determinant	Similarity Outcome
Radujkovic et al. [5]	+	+	+
Bennouar et al. [14]	+	+	+
Campi et al. [15]	+	+	+

Vitamin D has a vital role as an immunomodulator, which can increase immune reactions in the respiratory tract mucosa through the formation of antimicrobial peptides. Low vitamin D levels will affect the immune defense system, thereby increasing the risk of disease severity and mortality due to COVID-19. Calcitriol, which is the active form of vitamin D, can bind to vitamin D receptors presenting on T and B immune cells, antigen-presenting cells (APC) and respiratory epithelium. The binding between vitamin D and its receptor will form an antimicrobial peptide, namely cathelicidins, which can damage bacterial or viral cell membranes, including the SARS CoV-2 virus and defensins that function to induce inflammatory chemotaxis cells by increasing capillary permeability.[6] Vitamin D deficiency significantly increases the risk of pneumonia and the occurrence of thrombotic episodes that are frequently seen in

COVID-19 patients.[9] Low vitamin D levels may exacerbate the incidence of cytokine storm, which is one of the leading causes of death in severe COVID-19, through increased mechanisms of inflammatory cytokines, such as TNF-α, interferon-γ, and IL-6 and decreased inhibitory cytokines.[6]

Based on Lohia et al.[4] study, the groups with higher risk vitamin D deficiency were the elderly, obese, and men. The highest COVID-19 mortality rate is also known to occur in these groups. This was also found in Radujkovic et al.[5], where 63% of patients in the entire cohort with vitamin D deficiency were aged 60. However, there was no significant difference in vitamin D levels in men and women. Bennouar et al.[14] also found that most of the subjects were male (69.2%) with a mean age of 62.3±17.6 years old and most had low levels of vitamin D, in the vitamin D insufficiency group (19.2%), vitamin D deficiency (29.2%) and the severe deficiency (26.7%). Several literatures recommend maintaining a minimum vitamin D level of 30 ng/mL to have optimal health conditions and it will hopefully prevent from COVID-19 infection.[4] Vitamin D is known to prevent cytokine storms, and ARDS events which are the leading cause of death in COVID-19 because of its role in the immune system.[6] Campi et al also showed that vitamin D serum levels were inversely associated with IL-6 in severely symptomatic COVID-19 patients (IL-6, r = -0.282, p-value = 0.004).[15]

All studies by Radujkovic et al.[5], Bennouar et al.[14], and Campi et al.[15] have several advantages. First, all of these studies have representative subjects of the existing population. In Radujkovic et al.[5] and Campi et al.[15] studies, COVID-19 patients were divided based on mild clinical symptoms and severe symptoms; therefore, they had ruled out the severity of COVID-19 as a confounder. Bennouar et al.[14] study only used severe COVID-19 patients. Second, vitamin D levels were measured on hospital admission, unlike some studies that used vitamin D levels several months/years earlier. Third, the objective measurement of hospital mortality and adjusted analysis of several confounding factors in these studies further illustrated the relationship between vitamin D levels and patient mortality. However, there are also some weaknesses in these studies, such as the sample size being not too large and is a single-center design. In Bennouar et al.[14] study, the amount of mortality that occurred after 28 days was unknown, and other risk factors for mortality in COVID-19 patients related to vitamin D deficiency such as obesity, ethnicity, and socioeconomic status were also unknown. These factors may be associated with mortality in severe COVID-19 patients.

Based on the critical review from these literature, we believe that a longitudinal study is needed with a longer duration, with a larger number of research subjects involving other factors that could potentially be confounding factors such as body mass index, socioeconomic status, comorbid disease, or ethnicity. Therefore, the relationship between vitamin D levels and mortality in severe COVID-19 patients would be more accurate, leading to a decrease in COVID-19 patients mortality rate.

Conclusion

Based on the critical review for both articles, it was found that vitamin D is one of the prognostic factors for mortality in severe COVID-19 patients. Severe COVID-19 patients with severe vitamin D deficiency have a higher risk of death. We recommend vitamin D levels assessment to be one of the routine examinations in COVID-19 patients to predict the prognosis. Furthermore, administering vitamin D supplementation to COVID-19 patients is also essential to maintain vitamin D levels to improve the immune system and provide better outcomes for patients. Maintaining vitamin D levels in optimum range is also essential for the prevention of COVID-19. However, further research is needed to assess the relationship between vitamin D levels and mortality in COVID-19 patients more accurately by involving other confounding factors.

Conflict of Interest

Authors declared no conflict of interest regarding this article.

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ORIGINAL PAPER

Immunization status lowers the incidence of stunting in children 1-5 years

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Abstract

Stunting is a multifactorial condition where a toddler has less body length compared to their age. One of the factors is the immunization status of children, which can lead to susceptibility to infection and caused growth disturbance. This study was conducted to determine whether immunization plays a role as one of the interventions to prevent stunting in children aged 1-5 years by using a cross-sectional observational study with a total of 110 children aged 1-5 years who visited the Public Health Center of Jatinegara District, East Jakarta between September-November 2019. Questionnaires, anthropometric assessment using body length board and microtoice, and Z-score assessment were obtained during the study. The Chi-square test was performed for data analysis. The result of this study showed that 47,3% of respondents had incomplete immunization status, and 84.6% of the child were stunted. Immunization plays a role as one of the factors preventing stunting in children aged 1-5 years (p<0,001). It can be concluded that immunization is one of the factors that contribute to lowering the incidence of stunting in children aged 1-5 years.

Keywords: stunting, immunization, children, age 1-5 years

Introduction

Stunting is a multifactorial condition where a toddler has less body length compared to their age. Based on the World Health Organization (WHO) child growth standard, stunted children were categorized as Z-score <-2SD. Stunting plays a major role in determining children's long-term growth and it can also affect social-economic problems. Based on the Indonesia Ministry of Health report in 2017 on the global prevalence of stunting, 55% of stunted children are in Asia, and Indonesia is ranked third among the highest stunting prevalence (36,7%) in South-East Asia between 2005-2017.[1]

Many factors play a role in stunting such as gender, age, low birth weight, history of infection, exclusive breastfeeding, family income, nutritional intake, maternal conditions during pregnancy, environmental sanitation, and also immunization.[2] World Health Organization has recommended that immunization and nutritional intake are the basic needs for children's growth and one of a few major preventions against stunting.[3] Indonesia's government has implemented Universal Child Immunization (UCI) with the aim of 100% of children being completely immunized, however, up

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to 2014 UCI in Indonesia had only 80% of children coverage who were completely immunized.[4]

Infections can mediate the changes in the body's ability to absorb and are also responsible to decrease the nutrients in the body. Infections can cause malabsorption, intestinal damage, activation of the immune system, and also reduced nutrient intake which will cause nutrient loss.[5,6]

Immunization was given to increase the child's immunity to specific pathogens and prevent further infections. Children under five years have an immature immune system known as anti-inflammation which susceptible to infections. Exposure to pathogens will activate the immune system to produce specific antibodies and cytokines to fight the pathogens. If the infections are repeated or chronic they can cause high levels of cytokines in the blood and suppress a child's appetite by increasing the production of leptin and decreasing the production of ghrelin. Leptin plays a role to inhibit appetite, while ghrelin plays a role to increase appetite in individuals. Repeated and chronic infections also inhibit the production of growth hormones.[7]

Previous studies showed different results. Swathma et al.[8] stated that children with incomplete immunization status had a 6 times higher risk of stunting. Fajariyah et al.[9] stated there is a relationship between complete immunization status and the occurrence of stunting. Children with incomplete immunizations status tend to be easily infected by pathogens which leads to high cytokine levels and stimulates higher leptin resulting in decreased appetite for children that will cause faster energy loss and high level of cytokines will also inhibit the work of growth hormones causing growth disruption and leads to stunting.[10,11]

In contrast to previous studies, Setiawan et al.[12] stated both complete and incomplete immunization status had the same risk of stunting. Azriful et al.[13] stated that there is no relationship between immunization status and the incidence of stunting. This is because of the multifactorial nature of stunting, immunization is just one of the factors, there are still a lot of other factors that play a role in stunting such as low birth weight, history of infection, exclusive breastfeeding, family income, nutritional intake, maternal conditions during pregnancy, environmental sanitation, and also immunization.[2] The possibility of herd immunity helps to prevent stunting even though the children's immunization status is incomplete.[12]

According to the Basic Health Research or Riset Kesehatan Dasar (RISKESDAS) in Indonesia in 2010, 2013, and 2017 the prevalence of stunting showed an insignificant decline. Central Java is also known as one of the large provinces in Indonesia and still had a high prevalence of stunting 20-30%. Immunization is one of the interventions to protect children from specific infections. Children who have incomplete basic immunizations are more vulnerable to infections which can cause a decrease in appetite and growth disruption. Complete basic immunizations are one of the preventions to control childhood infections and can also maintain optimal child's nutritional status.[3]

Based on differences in previous studies and the possibility of immunizations to prevent stunting and maintains children's nutritional status, this study's objective was to determine the relationship between immunization status and the incidence of stunting in children aged 1-5 years by separating the children's age into four groups with the distance within one year from each group.

Methods

Study Design

This study was an observational study using a cross-sectional design. This study was conducted in the Public Health Center of Jatinegara District, East Jakarta, Indonesia from September to November 2019.

Population and sample

The study population was children aged 1-5 years who visited the Public Health Center. The sample consisted of 110 children aged 1-5 years fulfilling inclusion criteria and was selected by consecutive non-random sampling.

Study variables

The dependent variable was stunting, and the independent variables were immunization status, gender, and age. Children were divided based on gender and age. Gender was divided into boys and girls, while age was divided into four groups that consisted of 12-23 months, 24-35 months, 36-47 months, and 48-60 months. The inclusion criteria in this study were children aged 1-5 years who visited the Public Health Center and had maternal & child health books. The exclusion criteria in this study were children aged 1-5 years who had a history of low birth weight and short stature due to genetic and/or congenital disorders. All parents of the subjects signed the informed consent form.

Study instruments

The study instrument used for data collection was a questionnaire to determine age, gender, history of low birth weight, genetic disorder, and growth hormone deficiency. Another instrument used for this study was a Maternal and Child Health Book (*Buku Kesehatan Ibu dan Anak*/ KIA) to collect data on child's immunization records. The immunizations status was complete if the child was fully immunized that consisting of 1 dose of *Bacille Calmette-Guerin* (BCG), 3 doses of Diphtheria-Pertussis-Tetanus (DPT), 4 doses of Polio, 3 doses of Hepatitis B, and 1 dose of Measles and considered incomplete when the child missed one or more dose of the scheduled immunizations, or not fully immunized. After the immunization status was collected, the child's height/ length was measured by using a microtoice instrument for the height of children >24 months and a length board for the length of children < 24 months. A child's body length/ height and age were assessed in Z-scores using the WHO growth standard for boys and girls aged from birth up to 5 years.

Data analysis

Data analysis using Chi-square test with SPSS 26.0 program in the Windows operating system. Univariate analysis was used to determine the frequency of each variable. Bivariate analysis was used to determine significant relationships between dependent and independent variables.

Results and discussion

Subject characteristic

The results in Table 1 showed that 66 (60%) of the subjects were girls, 43 (39.1%) aged between 12-23 months, 58 (52.7%) subjects have complete immunization status and 64 (58.2%) subjects were not stunted.

Table 1 showed that 66 (60%) of the subjects were girls, meanwhile in Jombang District, showed that the subjects were mostly boys (55.7%) than girls (44.3%).[14] Other studies conducted in Babakan Madang, West Java showed the subjects were mostly girls (51%) than boys (49%).[15]

This study categorized the subject's age into four groups and most subjects' age was 12-23 months (39.1%), followed by 24-35 months (25.5%). In the previous study, subjects' age was divided into two groups and the majority of subjects were < 24 months (82.2%) and in line with this study.[14] Study which was conducted in Rwanda categorized the subjects' age into three groups and the majority of subjects were between 24-59 months old (58%).[16]

Tabel 1. Subject Characteristics

Variable	Category	Frequency (n)	Percentage (%)
Gender	Girls	66	60.0
	Boys	44	40.0
Age	12-23 months	43	39.1
	24-35 months	28	25.5
	36-47 months	27	24.5
	48-60 months	12	10.9
Immunization status	Complete	58	52.7
	Incomplete	52	47.3
Stunting	Yes (<-2SD)	46	41.8
	No (>-2SD)	64	58.2

Most of the subjects in this study had complete immunization status (52.7%) and were not similar to previous studies. The study by Nurdin et al.[2] conducted in Palu, found the majority of subjects' immunization statuses were incomplete (55.6%), and not similar to the study by Azriful et al.[13] where most of the subjects' immunization status were

incomplete (79.1%). It has been reported that complete immunization status coverage in Jakarta in 2018 reached 68%, but was below the national target.[17] The low coverage of immunization in Indonesia, especially DKI Jakarta, classified as an urban area, could be caused by various factors, as stated in the study by Triana et al.[18] This could be due to low parental education, parental knowledge, and parental attitudes in responding to immunization. Parents of respondents in this study tend to have low knowledge about immunization, where on average they knew that complete basic immunization is only enough for one dose of each vaccination, However, complete basic immunization as stated by the Ministry of Health consisted of 1 dose of *Bacille Calmette-Guerine* (BCG), 3 doses of Diphtheria-Pertussis-Tetanus (DPT), 4 doses of polio, 3 doses of hepatitis B, and 1 dose of measles.[18,19]

The prevalence of stunting in this study was 41.8%. Based on RISKESDAS 2018, Indonesia has managed to decrease the prevalence of stunting since 2013 from 37.2% to 30,8%. Jakarta has a lower stunting prevalence compared to the National prevalence, the prevalence of stunting in Jakarta is around 17.7%.[20] The prevalence of stunting in this study was higher than both National and Jakarta's prevalence of stunting.

Relationship between gender, age, immunization status, and stunting

Table 2 showed from the total of 110 subjects based on gender 25 (27.5%) of girls were stunted, aged 12-23 months 19 (17.3%) were stunted, and 44 (40%) of subjects who had incomplete immunization status were stunted. It has also been found that there was no relationship between gender (p=0,305) and age (p=0,206) compared to the incidence of stunting, however, there is a relation between immunization status with the incidence of stunting (p<0,001).

The result of this study showed there was no relationship between gender and stunting, the majority of subjects are girls. Setyawati et al.[21] stated there was no relationship between gender and stunting. A study conducted by Kirsten et al.[22] also stated there was no relationship between gender and stunting. In the first year of life during infancy boys have less height status than girls, but boys' height increased following their age, also the difference in nutritional intake and parenting for each individual plays a role in child growth. Boys tend to have higher meal frequency after age 2-3 years, but in some low-to-middle income countries, girls have a higher risk of stunting due to the gender discrimination that will affect their nutritional intake which results in an under-nutrition that led to stunting. Overall gender does not play a significant role to determine stunting, with both genders having a high risk of stunting. [22,23]

In contrast with this study, research conducted by Alphonse et al.[16] showed there is a relationship between gender and stunting, and it appeared that stunting mostly occurred in boys at an early age of life. Garenne et al.[24] also stated that boys under 30 months of age had a higher risk of stunting. This is due to *Follicle Stimulating Hormone* (FSH) and *Luteinizing Hormone* (LH) in girls being higher from an early age and helping to fasten the growth.

Tabel 2. The relationship between gender, age, immunization status, and stunting

Variable	Category	Stunting				Total	p
		Yes		No			
		n	%	n	%		
Gender	Girls	25	27.5	41	37.3	66	0.305
	Boys	21	23.1	23	20.9	44	
Age	12-23 months	19	17.3	24	21.8	43	0.206
	24-35 months	8	7.3	20	18.2	28	
	36-47 months	15	13.6	10.9	27	27	
	48-60 months	4	3.6	8	7.3	12	
Immunization status	Complete	2	1.8	56	50.9	58	0.001*
	Incomplete	44	40	7.3	7.3	52	

*The statistical result using Chi-square test with a significance value p<0.05

However, boys tend to reach their hormonal peak point around puberty. Based on the way of parenting between boys and girls also plays a role in determining to stunt. It is stated that boys tend to be released to the outside world more quickly so that the possibility of being exposed to infection is higher than girls. Generally, boys are given complementary foods earlier before the age of 6 months which makes boys more susceptible to the exposure to diarrhea and recurrent infections that can interfere with their growth and development.[23,24]

This study showed no relationship between age and stunting, and the majority of subjects aged in this study were 12-23 months. Schrijnner et al.[26] stated there is no significant relationship between age and stunting. The introduction of complementary food at an early age can affect child growth but tends to diminish over time because of other factors such as better nutritional intake and parenting during the golden period of life. In general, both studies stated there is no relationship between age and stunting in children under five years old.

In contrast, Alphonse et al.[16] found a relationship between age and stunting. Garenne et al.[24] also stated there is a relationship between age and stunting, especially in children under five years. Stunting also was a reversible condition in children >24 months due to the adequate intervention of nutritional intake during the golden period of life, known as catch-up growth. Children >24 months should be easier to follow their catch-up growth due to children in this age having a larger appetite than children aged < 24 months and also relying fully on the nutritional intake given by the parents. This condition also made catch-up growth a critical window due to the difference in parenting and nutritional intake given by the parents in each child individually.[16,23]

Stunting prevalence globally occurred in children aged 12-36 months. At the age of 24 months, breastfeeding stops being given and children will depend entirely on the food provided by the parents at this time the nutritional status of the child needs to be considered and there are frequent nutritional problems, in addition, children's motor skills increased rapidly at the age of 24 months and the possibility of infection also increases, due to this theory the prevalence of stunting at the age of 24 months increases. Furthermore, children's motor skills increased rapidly at this age and the desire to know the surrounding environment increases which leads to the possibility of infection also increases, so at the age of 24 months there is a high enough risk of nutritional problems and infection, and the prevalence of stunting at the age of 24 months increases.[21,23]

The result of this study showed a relationship between immunization status and stunting, the majority of this study had complete immunization status. A study conducted by Berendsen, et al.[7] stated there is a relationship between immunization status and stunting.[7] Another study conducted by Fajariyah et al.[9] also stated a relationship between immunization status and stunting. World Health Organization has recommended immunization as one of the interventions to prevent stunting in children, Public Health services are also campaigning for immunization as prevention of stunting. By having complete immunization, the child's body will produce memory cells against certain infections and prevents children from exposure to pathogens. However, children with incomplete immunization status tend to easily be infected by pathogens which leads to high cytokine levels and stimulates higher leptin that resulting in decreased appetite for children when this is activated for a long time, especially during repeated or chronic infections it will cause rapid energy loss and cytokines produced will also inhibit the work of growth hormones causing growth disruption and lead to stunting. [7,10,11]

Besides preventing stunting, complete basic immunization also helps promote catch-up growth in stunted children. If stunted children receive a complete dose of basic immunization, they will have the same IgG level as a non-stunted child with complete basic immunization. [13,21]

In contrast to this study, Arya et al.[27] stated there was no relationship between immunization status and stunting. Setiawan, et al.[12] also stated both complete and incomplete immunization status had the same risk on the incidence of stunting. Immunization is not the only factor to prevent

stunting, adequate nutritional intake, low birth weight, history of infection, exclusive breastfeeding, family income, maternal conditions during pregnancy, and environmental sanitation are all factors contributing to optimal growth.[2] Recent studies also stated that herd immunity played a role in preventing stunting in incomplete immunized children. Herd immunity can increase community immunity to a specific pathogen because the community is mostly immunized, and children who are not immunized will be protected by the community's immune system so they are protected against infection.[12]

The limitation of this study is the lack of laboratory evidence to exclude genetic disorders and growth hormone deficiency. Further research is suggested to include laboratory evidence to exclude genetic disorders and growth hormone deficiency, also other factors that also play role in stunting need to be excluded such as a history of maternal nutritional status during pregnancy and before pregnancy, child's nutritional intake, and the history of exclusive breastfeeding. Public Health Center can improve the IEC program (Information, Education, Communication) regarding the health of children aged 1-5 years, especially the importance of immunization in children.

Conclusion

This study showed that there is a significant relationship between immunization status and the incidence of stunting among children aged 1-5 years. Complete immunization prevents children from exposure to pathogens by, producing memory cells against certain infections and also helps child's catch-up growth. This study also showed no significant relationship between age and gender in the incidence of stunting in children aged 1-5 years. Both the government, physicians, and health workers should continuously build social awareness to increase immunization targets.

Conflict of Interest

Authors declared no conflict of interest regarding this article.

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ORIGINAL PAPER

The association between dietary diversity, social assistance and coping strategy with household food security during COVID-19 in Tulungagung district, East Java

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Abstract

Background : Food insecurity is still prevalent in Indonesia and COVID-19 impacts led to severe and widespread increases in food insecurity, affecting vulnerable households with impacts expected to continue into 2022 and possibly beyond.

Objective : This study aimed to determine the association between dietary diversity, social assistance, and coping strategies with food security during COVID-19 in Tulungagung, East Java.

Methods : This cross-sectional study was conducted in Tulungagung District, East Java with interviewed using telephone from May to July 2021. Multistage random sampling was conducted to 187 parents (father or mother). The study used structured questionnaire for socio demographic background, Household Food Insecure Assess Scale (HFIAS), dietary diversity scale, coping strategy index instruments to collect the data.

Results : This study found the prevalence of food insecurity in Tulungagung were 56.1%. There was association between income (p=0.021, OR= 2.388(1.123-5.079)), dietary diversity (p=0.007, OR=3.400(1.440-8.200)), number of coping strategies (p=<0.001, OR=10.020(5.055-9.861)), and coping strategies food compromisation (p=<0.001, OR=13.337(5.835-3.485)) with food security.

Conclusions : Most households have faced food insecurity because of lower income during the pandemic, have low dietary diversity, and tend to use coping strategy to survive. By this finding, it is important for government to give priority and focus on vulnerable household in social assistance for the long term and more focused to build up human capital among households through skill and training to ensure the resilience of food security.

Keywords: food security, dietary diversity, social assistance, coping strategy, COVID-19

Introduction

Household food security is a situation that exists when all people at all times have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life.[1] Indonesia's food security has improved from 2015 to 2019, which was previously ranked 75 to 62 currently out of 113 countries but more than 20 million Indonesian people still face the risk of hunger and it could get worse because of COVID-19 pandemic. It showed the proportion of households facing moderate or severe food insecurity rose to 11.7% during the

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COVID-19.[2] Impact of food security is a high likelihood that malnutrition will increase across the country as poorer households have to focus on providing sufficient quantities of food to their members rather than the quality of a diversified diet. The worldwide economic consequences of the pandemic harm Indonesia's economy through the drop in trade of goods and services, loss of jobs and income and decreased domestic products. There has been a drastic rise in job losses with more than 6.4 million Indonesians having filed for unemployment and almost three-quarters of households because of pandemic were earning less than they were in January 2020. Due to the current situation, this virus has the potential to severely affect the health and socioeconomic status.[3]

Food insecurity makes families may purchasing more lower-cost, shelf-stable foods that are often less healthy and lower in key nutrients.[4] The multiple consequences of the economic shocks not only included reductions in food consumption and dietary energy intake, but also compromised diet quality and diversity.[5] Significant reductions in the consumption of fruits, vegetables, meat and dairy and shift to nonperishable foods like flour, maize meal and rice has the potential to deepen malnutrition. Poverty also make household cannot afford to purchase food to perform their daily activities or provide adequate housing, quality health care facilities or quality education for their families.[6] Food insecurity is more also likely to happen when there is absence of social assistance. Social assistance can reduce extreme poverty and enhance food security, while also building household resilience in times of crisis.[7] The government has responded swiftly with a scaling up of social assistance programs but challenges with the social assistance database remain, including the risk of missing many of the most vulnerable.[8] Food insecure households also reportedly exhibit a range of coping techniques that reflects their vulnerability. In the phase of shocks such as COVID-19, households may employ food or non-food based coping strategy or a combination of both to protect their basic needs.[9] When the food insecure households adopt different coping strategies, they often also convert to a new livelihood pattern that might make them more vulnerable to under nutrition.[10]

Tulungagung district is areas for agricultural activities and about 60% of people livelihoods are mostly farmers. Tulungagung become one of the food barns in East Java Province to maintain national food security.[11] COVID-19 restrictions adversely affected the agricultural sector as demands for food stuffs fell considerably and also reduce the operation time of traditional markets and even to close them. This policy made it difficult for farmers to sell their products and can impact to their income.[12] Children also face a high risk of malnutrition because low dietary diversity. Toddlers eat a variety of foods reached 59.7%, not yet reached the 80% target in Tulungagung and it can worse because of COVID-19.[13] Unemployment in Tulungagung district reached 4.61%, the highest in the last 3 years and poverty rate in Tulungagung increased from 6.74 to 8.11% during COVID-19.[14]

Research on food security during COVID-19 is very timely during COVID-19 pandemic. Information whether the COVID-19 pandemic may worsen this problem at household level and factors may involve are lacking. Therefore, this study aims to know the association between dietary diversity, social assistance, and coping strategies with food security during COVID-19 in Tulungagung, East Java.

Methods

Subjects and Study Design

The design of this study was cross-sectional study and conducted in May-July 2020. The total sample was 187 parents (mother or father). Sample size was calculated using estimate difference between two population proportions. Total sample was 170 respondents and added by 10% (17 respondents) to secure sample from any drop out or incomplete data, resulting in a total sample size of 187 respondents. Subjects were selected using a probability sampling technique with random sampling. Two villages in Kauman with 100 respondents and Mangunsari with 87 respondents in Tulungagung district were

become representative.

Data collection was conducted by enumerators who have previously been trained for one week. Researcher visit village office to get the list of respondents and get the respondent's telephone number. The researcher and enumerators then contact the respondent to explain about the research through what Sapp text or call and if they agree then they are added to the what Sapp group. The distribution of the questionnaire was carried out using Google Forms and distributed in what Sapp group. The questionnaire consists of 6 parts. Part 1 contains informed consent (willingness), part 2 identity data subject consists of 4 questions, part 3 socio-demographic consists of 7 questions, part 4 social assistance consists of 6 questions, part 5 about impact of COVID-19 consists of 11 questions, part 6 about dietary diversity consists of 16 questions, part 7 about household food security consists of 9 questions, part 8 about coping strategy consists of 10 questions. We interviewed each subject for 30-40 minutes through telephone interview. We used structured questionnaire to assess demographic data, social assistance, and food security status, dietary diversity, and coping strategy. Researcher were measured household food security using the Household Food Security Access Scale (HFIAS), a measure that reflects a household's food security for the previous month. The questionnaire consists of nine occurrence questions that represent a generally increasing level of severity of food insecurity (access), and nine frequency of occurrence questions that are asked as a follow-up to each occurrence question to determine how often the condition occurred.[15] Household dietary diversity were measured using Household dietary diversity scale (HDDS) that reflects household access to a variety of foods.[16] Coping strategy measured using Coping Strategies Index (CSI) that is a series of questions about how households manage to cope with a shortfall in food for consumption.[17]

The questionnaire was pilot tested in a similar population to ensure its applicability in collecting the required data. The inclusion criteria were father or mother who live in Tulungagung for the last 6 months and willing to participate and signed the informed consent. Those who were the presence of severe food allergy or chronic medical problem affecting food intake in household. Sample size was determined based on estimate difference between two populations proportions with specified absolute precision with samples was 187 subjects.

Data Collection

Data collection was conducted from May to July 2021 after it was submitted and approved by the Ethics Committee of Faculty of Medicine, University of Indonesia – Cipto Mangunkusumo Hospital (KET.425/UN2.F1/ETIK/PPM.00.02/2021). There were 5 enumerators that have experienced become enumerator related to public health and been trained for one week in this study. Data obtained through the telephone interview process.

Sociodemographic data

Subject's sociodemographic data including age, education, occupation, income, marital status, number of children, number of household member, and type of family were obtained through telephone interviews. Education was categorized into high (graduated from senior high school and above), and low (graduated from middle high school and below). Occupation was categorized into employee and not employee. Income was categorized into two groups, more than, and less than or equal to the value of minimum wage (UMK) in Tulungagung (Rp 2,000,000). Marital status was categorized into two groups, married and divorced. Number of children was categorized into <3 and ≥3. Number of household member was categorized into two groups, ≤4 and >4. Type of family was categorized into two groups, nuclear and extended family.

Dietary Diversity

The assessment of dietary diversity was done through an interview by 5 enumerators using a household dietary diversity score (HDDS to reflect, in a snapshot form, the economic ability of a household to access a variety of foods. Household Dietary Diversity Score (HDDS) calculated by summing up the number of food or food group eaten

over the past 24h by any member of the household (19). In total, the 12 food groups (FG) were as follows: (FG1) cereals; (FG2) tubers and roots; (FG3) vegetables; (FG4) fruits; (FG5) meat, poultry, organ, etc.; (FG6) eggs; (FG7) fish and others seafood; (FG8), pulses, legumes and nuts;(FG9), milk and other dairy products; (FG10) oils and fats and butter; (FG11) sugar and honey; and (FG12) miscellaneous foods such as condiments and processed foods like snacks, and beverages. We assigned values for each group as '0' for the negative answer (not consumed), or '1' for the positive answer (consumed). Category for formula based on HDDS Indicator with lowest dietary diversity ≤3 food groups and high dietary diversity ≥6 food groups .[16]

Social Assistance

Social assistance was performed to obtain data about social assistance refers to government programs that provide a minimum level of income support to individuals and households living in poverty and what kind of program the received either in the form of direct cash transfers or through a variety of in-kind benefits.

Coping strategies

Coping strategies were performed to obtain data about behaviours developed, the main question becomes how often in the past one month had to rely on each individual coping behaviour. The coping strategy adapted in this study consists of nine questions. Each question shows the strategy taken by the respondent to ensure that they have enough food to consume despite financial or food shortage. There are 3 question which is the type of coping strategy that most adopted by the respondents, the frequency of coping strategy adopted by the respondents that being categorized into food compromisation, financial, and both food compromisation-financial coping strategy and the number of coping strategies adopted. Food compromisation consist of consume less preferred/less expensive food, limit portion size at mealtimes, try to grow food plants by own selves, reduce number of meals eaten a day, and restrict adult consumption for small children to eat, not eating at all. Financial consist of borrow food or money from a friend or relative, borrow money to buy food, purchase food on credit. [17]

Household Food Security

Researcher were measured household food security using the Household Food Security Access Scale (HFIAS), a measure that reflects a household's food security for the previous month. The questionnaire consists of nine occurrence questions that represent a generally increasing level of severity of food insecurity (access), and nine frequency of occurrence questions that are asked as a follow-up to each occurrence question to determine how often the condition occurred. The respondent will be asked about whether the condition in the question happened at all in the past four weeks (yes or no). If the respondent answers "yes" to an occurrence question, a frequency-of-occurrence question is asked to determine whether the condition happened rarely (once or twice), sometimes (three to ten times) or often (more than ten times) in the past four weeks. The HFIAS score range from food secure with Food secure (score 0-1), Mildly food insecure (score 2-8), Moderately food insecure (score 9-16), Severely food insecure (score 17- 27).[18] After that HFIAS classification converted into binary classification with food secure score (0-1) and food insecure score (2-27). The higher the score then more food insecurity (access) the household experienced. The lower the score then less food insecurity (access) a household experienced. [15]

Statistical Analysis

Data were analyzed by using IBM SPSS version 20.0. Normality test was done by using Kolmogorov Smirnov. The data distribution was considered normal when the p value > 0.05. Continuous data were presented in the form of mean ± SD or median (minimum-maximum). Categorical data were presented in the form of a frequency distribution (n, %). Descriptive statistics of age were expressed as as median (min-max). Bivariate analysis was conducted using chi-square to identify any potential associations between variables and household food

insecurity and to assess crude odds ratio. The level of significance was set at $p<0.05$.

Results

Socio demographic, dietary diversity, social assistance, coping strategy and food security distribution

The respondents analysed in this present study were 25-77 years old (median = 38 years old). Respondents were 181 mother and 6 father. Overall, the prevalence of parents who have high education s 70.1%, who married 84%, who have <3 children 75.9%, who have children under 5 <3 97.9%, number of household member who have ≤4 member 72.7%, nuclear family 75.4%, and employed 61%, income 68%, and food expenditure 81.3%. Distribution of Household's sociodemographic was presented in **Table 1.** Most of the household received social assistance from government 71.7% and village cash transfer was the most common assistance received by the households 47.1%. The majority of household have low dietary diversity 77.5% and cereals consumed by all households. Household in a situation that have urgency to meet food adopted coping strategy 89.8% and most of them using both coping strategy 89.8%. More than half of the household food secure 56.1%. Distribution of dietary diversity, social assistance, coping strategy, and food security was presented in

Table 2.

Table 1. Sociodemographic data of the household (n=187)

Sociodemographic	Frequency (n)	Proportion (%)
Age	38 (25-77) *	
25-45	121	64.7
46-65	58	31
>65	8	4.3
Sex		
Female	181	96.8
Male	6	3.2
Educational		
Elementary School-junior	56	70.1
Senior highschool-university	131	29.9
Marital status		
Married	158	84.5
Divorced	29	15.5
Number of children		
<3	142	75.9
>3	45	24.1
Number of household member	136	72.7
≤4	51	27.3
>4		
Type of the family	141	75.4
Nuclear	46	24.6
Extended		
Occupation of parents	114	61
Employed	73	39
Not employed		
Income	127	68
Below minimum wage	60	32
Above minimum wage		

Table 2. Distribution of dietary diversity, social assistance, coping strategy, and food security

Sociodemogaphic	Frequency (n)	Proportion
Social assistance received		
Yes	134	71.7
No	53	28.3
Social assistance programs		
Food aid	42	22.5
Village cash transfer	88	47.1
Electricity subsidy	37	19.8
Family hope program	23	12.3
Pre employment card program	28	15
Household dietary diversity		
High dietary diversity	42	22.4
Low dietary diversity	145	77.5
Coping strategy adopted		
Yes	168	89.8
No	19	10.2
Food compromisation coping strategy		
Yes	117	62.6
No	70	37.4
Financial coping strategy		
Yes	137	73.3
No	50	26.7
Both coping strategy		
Yes	168	89.8
No	19	10.2
Household food security		
Food secure	105	56.1
Food insecure	82	43.9

The association between dietary diversity, social assistance, coping strategy with food security

Using Chi Square test, this study found no association between age (p=0.853), gender (p=0.128), education (p=0.886), employed (p=0.228), number of children (p=0.927), family member (p=0.149), family type (p=0.229), social assistance received (p=0.313), coping strategies financial (p=0.330), both coping strategies (p=0.335) with food security. However, there was a positive association between income (p=0.021, OR= 2.388(1.123-5.079), dietary diversity (p=0.007, OR=3.400(1.440-8.200), number of coping strategies (p=<0.001, OR=10.020(5.055-9.861), coping strategies food compromisation (p=<0.00, OR=13.337(5.835-3.485) with food security. Analyses of associated factors between socio demographic, dietary diversity, social assistance, coping strategy with food security were summarized in **Table 3.**

Table 3a. The association between dietary diversity and household food security (n=187)

	Food Security (n, %)		Total	p-value*	OR (CI 95%)**
	Food Insecure	Food secure			
Dietary diversity					
Low dietary diversity	49 (53.8)	42 (46.2)	91	0.007	3.400 (1.440-8.200)
High dietary diversity	33 (34.4)	63 (65.6)	96		

*p-value<0.05
*Crude OR

Table 3b. The association between social assistance and household food security (n=187)

	Food Security (n, %)		Total	p-value*	OR (CI 95%)**
	Food Insecure	Food secure			
Social assistance received					
Yes	61 (46.2)	71 (53.8)	132	0.313	0.719 (0.378-1.367)
No	21 (38.2)	34 (61,8)	55		

*p-value<0.05
*Crude OR

Table 3b. The association between coping strategy and household food security (n=187)

	Food Security (n, %)		Total	p-value*	OR (CI 95%) **
	Food Insecure	Food secure			
Number of Coping strategies					
≤1	17 (21.1)	76(78.9)	93	<0.001	1.020(5.055-9.861)
>1	47 (17.6)	47 (82.4)	94		
Coping strategies financial					
Yes	63 (46)	74 (54)	137	0.330	1.389 (0.176-2.694)
No	19 (38)	31 (62)	50		
Coping strategies food compromisation					
Yes	74 (63.2)	43 (36.8)	117	<0.001	3.337 (1.835-3.485)
No	8 (11.4)	62 (88.6)	70		
Both Coping strategies					
Yes	90 (53.6)	90 (53.6)	19	0.335	3.250 (1.035-3.201)
No	4 (21.1)	15 (78.9)			

*p-value<0.05
*Crude OR

Discussion

Educational status is recognized to be not associated with household food insecurity in this study (p= 0.886). In contrast, association between education and food security was found from studies in Zimbabwe and Malaysia.[19,20] Alongside improving the household's income and access to food, education also provides employment opportunities. Education additionally helps farmers to adopt new technological inputs into agriculture, the proper application of fertilizers and engagement in other activities to generate income for the household, which enhances the household food security. A higher level of educational attainment amongst the household heads, especially women, influences proper food preparation and good nutrition practices.[21]

Employment status is recognized to be not associated with household food insecurity in this study (p=0.228). This finding consistent with the previous study which stated that there is no relationship between employment status and food security in Bangladesh.[20] In contrast, association between employment status and food security was found from studies in Iran.[22] This probably due to high unemployment rates among low-income populations make it more difficult to meet basic household food needs.[23] Number of children is recognized to be not associated with food security in this study (p=0.927). This finding consistent with the previous study which stated that there is no association between number of children and food security in India.[24] However, studies in Iran have shown that in poverty-stricken communities with inadequate household food access, some children grow and develop normally as a result of positive family and caregivers' behaviour. Good care practices include proper feeding, home health care, food preparation, hygiene and the provision of a responsive and stimulating environment to children during their most vulnerable stages.[25] Family member is recognized to be not associated with household food insecurity in this study (p=0.149). This finding consistent with the previous study which stated that there is no association between family member and food security in Indonesia.[26] In contrast, association between family member and food security was found from studies in Bangladesh.[27] A large family size puts an extra

burden on food consumption, and more likely to experience food insecurity in contrast to households with a small family size.[21] Family type is recognized to be not associated with household food insecurity in this study (p=0.229).[20] This finding consistent with the previous study which stated that there is no association between family type and food security in Indonesia.[26] It might be because of the household can reduce the adverse consequences of food insecurity if other household members are able to contribute to the total household income. In contrast, association between family type and food security was found in Jordan.[28] This implies that if number of households increases by 1 person, then food security status of households would decrease because an extended household affects the availability of food per capita in the family.[29] Marital status is recognized to be not associated with household food insecurity in this study (p=0.601).[20] This finding consistent with the previous study which stated that there is no association between marital status and food security in Indonesia.[26] The absence of the association can be attributed to the fact that majority of single-headed households are headed by females. Similar to the case of single-headed households, the female spouse in double-headed households is usually the one who looks for money and manage the income to solve family problems. In contrast, association between marital status and food security was found in Malaysia.[30] Higher prevalence of food insecurity was associated with the mother's status, whether single or separated, divorced, widowed, or married.[31] Social assistance received (government) is recognized to be not associated with food security proven by the (p=0.313). It has been shown that a one-off increase in social assistance benefits leads to a significant decrease in moderate and severe food insecurity. The study showed that 80% of households in Australia that benefit from financial social assistance also experienced a lack of food security. Thus, increasing financial social assistance may reduce severe effects associated with food insecurity in households. For example, in Newfoundland and Labrador in Canada, food insecurity dropped significantly in 2007–2011 because of social assistance reforms.[32]

However, there was a significant association in the bivariate analysis. Family income is recognized to be associated with household food security in this study (p=0.021). Studies conducted in Ghana demonstrated that monthly household income increased household food security by 1.65 times.[33] Due to their low socioeconomic status, poor households are not able to be food secured and acquire sufficient resources. This renders them vulnerable to limited access to food, which could further its redistribution to household members.[31] Study conducted in Vietnam which stated that the majority of respondents 66.9% had a decrease in household income due to COVID-19.[34] A study on Nepal also reports that 33.2% of respondents had a reduction in income and 5.4 percent job loss attributed to the COVID-19 pandemics.[35] The COVID-19 outbreak is adversely affecting the economic livelihoods and revenue of families. The low level of payment and the declining purchasing power of food tended to lead a less varied food. The higher a household's access to food, the higher the food security.[36] Significant association was also found between dietary diversity and household food security (p=0.007). Study in Kenyan showed that household dietary diversity scores fell from 9.5 to 8.6 during COVID-19.[37] The effects of COVID-19 on food systems in low-income and middle-income countries would include disruptions in food supplies as a result of restrictions on the movement of people, export restrictions that disrupted trade flows and supply chains including for staple foods (such as wheat and rice), economic downturn and loss of income. The impacts of these were expected to include decreased availability of food and increased food prices, resulting in lower access to food and shifts in consumer demand toward cheaper and less nutritious foods.[38] Disruptions to food transport or the lack of means to transport food commodities for sale would also have led to losses for farmers. Additionally, limited access to inputs (e.g., seeds and fertilizers) would have decreased production. A previous study performed in Ethiopia found that COVID-19 disruptions affected vegetable farmers because of limited access to services and the unavailability of on-farm labour, as well as increased production costs and decreased availability of inputs. The study found increased

food prices as a result of lower agricultural production and the need to import foods.[39] The study in Burkina Faso, Ethiopia and Nigeria also found that decreased crop production was associated with less diverse diets.[40] Previous findings in India also found that crop production can influence dietary diversity through production diversity and income pathways. The effects of COVID-19 on agriculture production and dietary diversity could be partially attributable to disruptions of supply chains, including for inputs, delayed or lower harvests, damage of perishable produce, and loss of income for farmers.[41] Various coping strategies were done by the households to overcome the food insecurity condition by doing food compromisation (quantity and quality of food) or financial coping strategies. From analysis, we found that coping strategies compromisation have a significant relationship with food security (p=<0.001). This result same with the previous study in Nigeria, the widely adopted food coping strategies by rural households during COVID-19 pandemic were eating less expensive food, reducing rational consumption, allowing children to eat first, and skipping meal within a day.[42] Study in Jordan also showed that food-related coping strategies studied were significantly associated with food insecurity at both levels ($p < 0.001$).[43] Furthermore, the association between food insecurity and food-based coping strategies was studied in food-insecure households in Ethiopia and it showed that most households responded to food insecurity by managing food left in their homes.[44] Similarly, a study of Vermont households revealed that food-insecure participants adopted food-related coping strategies significantly more than food-secure households. It is obvious that adopting food-related coping strategies is common for dealing with food insufficiency, which highlights the seriousness of the problem, especially among food-insecure households in the context of the COVID-19 pandemic.[45] From analysis, we also found that coping strategies have a significant relationship with number of coping strategies (p=<0.001). The more severe food insecurity status the higher proportion of coping strategies adopted.[46] Study in Bangladesh showed that one third of the households applied three to four coping strategies.[47] Similarly, study in Africa showed the more severe food insecurity status the higher proportion of coping strategies adopted.[48] Coping strategies can help to determine the food access level and identify the most vulnerable households.[49]

This study has limitation with using telephone interview which may suggest sampling bias by chance excluding those who do not have internet access. This may reduce the generalizability of the findings and because they cannot meet face-to-face or make video calls, it cannot validate the food diversity variable. In addition, although the dietary diversity scores can help determine food accessibility, they do not capture the amount of actual food consumption by households, and nor do they capture changes or reductions in diversity within food groups, which is important for food security. However, to the best of our knowledge, it was the first study in Tulungagung that measured household food security during the COVID-19 pandemic. This study also addressing multiple dimensions of food security so it can describe the vulnerability of the respondents. Tulungagung as a food barn that can affect the food security of other regions so that this research can be a good reference in looking at food security in Indonesia.

Conclusion

The outcome of this research revealed that 56.1% of the households were food insecure during COVID-19 pandemic. Food insecurity was significantly associated with household income, dietary diversity, coping strategy food compromisation, and number of coping strategies. By this finding, it is important for government to give priority and focus on vulnerable household in social assistance for the long term and more focused to build up human capital among households through skill and training to ensure the resilience of food security. This study also needs a support for further analysis and deeper understanding to be conducted in the future studies.

Conflict of interest

Authors declare no conflict of interest regarding this article.

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ORIGINAL PAPER

Disease-related malnutrition in congenital heart disease: what is the risk and impact on patients' outcomes?

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Abstract

The most frequent congenital defect in newborns is congenital heart disease (CHD). In children with CHD, malnutrition often occurs, posing negative impacts on their health. Malnutrition is associated with increasing morbidity and mortality rate in children with CHD. To decrease unfavorable outcomes, nutritional screening and management are indicated before and after surgery. This review focuses on delivering information on prevalent CHDs in children, as well as nutritional management before and after heart surgery.

Keywords: congenital heart disease, malnutrition, surgery

Introduction

Congenital heart disease (CHD) refers to all heart problems occurring before delivery. It comprises flaws in the heart architecture that obstruct venous outflow, cardiac section septation and sequence, and normal valve apparatus function.[1] It is the most typical congenital birth defect, accounting for almost one-third of all congenital defects.[2] Congenital cardiac disease affects 6 to 8 out of every 1000 newborns.[3] Due to various types of cardiac abnormalities, CHD frequently presents with a variety of signs and symptoms. Excessive perspiration, intense exhaustion, poor feeding, shortness of breath, fatigue, rapid heartbeat, chest pain, cyanosis (blue tinge to the skin), and clubbing fingernails are some of the symptoms of this illness. Clinical examination, chest x-ray, echocardiography, and electrocardiogram (ECG) are among the various diagnostic workup for this disease. If the transthoracic windows are not optimum, a transesophageal echo may be needed. Children with pulmonary hypertension and probable

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pulmonary vascular disease often need to undergo diagnostic catheterization.[2]

Malnutrition often occurs among children with CHD due to many factors. Malnourished patient is more likely to acquire infection and have poor wound healing due to fewer nutritional substrates available to respond to the enhanced catabolic consequences of injury from cardiac surgeries.[4]

The review aims to provide information on common CHD in children as well as nutritional management before and after heart surgery.

Classification of CHD

1. Acyanotic heart disease

1.1. Atrial septal defect

The second most prevalent congenital heart disease is atrial septal defect (ASD), comprising around 7-10% of all CHDs.[3,5] When the communication between the right and left atria is not closed, an atrial septal defect occurs. Because the left atrium level is higher than the right one, ASD causes a left to right shunt.[6] If the septum is damaged or absent, oxygen-rich blood from the left side of the heart can flow directly to the oxygen-poor blood in the right one (left-to-right shunt), or vice versa.[9] Ostium secundum, sinus venosus, ostium primum, patent foramen ovale and coronary sinus defects, are the five major types of ASD. A quiet systolic crescendo-decrescendo outflow tract murmur, as a result of a rigid split in the S2 heart sound, may be heard on physical examination due to increased flow over the pulmonary valve.[10]

Small ASDs are likely to shut on their own and do not require closure. On echocardiogram, right ventricle volume overload (dilatation of the right side of the heart, with flat-to-paradoxical interventricular septal flow) and a pulmonary-to-systemic flow ratio of more than 1.5:1.[10] are both indications for ASD closure. Elective surgical or catheter-based closure is suggested to be delayed until the patients are up to 3-5 years of age. Closure is not performed on infants unless they are exhibiting symptoms.[8]

1.2. Ventricular septal defect

The most common CHD is ventricular septal defect (VSD), which affects nearly half of all children with CHD. The interventricular septum, splitting the heart's right and left ventricles, will be defectively formed, and VSD develops as a result.[5,12] A left-to-right shunt occurs after an uncomplicated VSD causes oxygenated blood to flow from the high pressure in the left ventricle to the low pressure in the right ventricle, and back into the lungs. As a result, the patient is acyanotic.[5,13] The characteristic pansystolic murmur, best-heard at the left mid-to-lower sternal border, could go unnoticed until the shunt becomes maximum at a few weeks of age.[3,5] In general, the smaller the defect, the more intense the murmur.[3,5]

Anti-congestive medications, such as furosemide, chlorothiazide, and/or spironolactone, are employed in the management of VSD with congestive heart failure symptoms.[5] The reduction of afterload is required to promote direct systemic flow from the left ventricle, reducing the sum of left-to-right shunting through the defect. Angiotensin-converting enzyme inhibitors (ACEIs) are employed to reduce afterload.[5] Milrinone can also be given intravenously to produce inotropy and afterload reduction, but this is normally reserved for patients who are about to undergo surgery.[13] Patients with failure to thrive might require caloric intake of up to 125 until 150 kcal/kg per day from fortified formula.[5]

The size and type (location) of VSD are the most important factors in determining whether or not surgery is necessary. Small VSDs do not need to be closed. Anti-congestive treatments should be used first for moderate VSD with congestive heart failure. A large VSD should be closed if the right ventricular and pulmonary artery pressures are equivalent to the left ventricle and aortic systolic pressures. VSD closure should be done before the child turn 6 to 12 months (should not exceed 18 months of age).[5]

1.3. Patent Ductus Arteriosus

Ductus arteriosus that failed to close in 72 hours post-delivery is known as patent ductus arteriosus (PDA).[15] All newborns have an arterial duct, which

is a typical connection between the aorta and the pulmonary artery that exists since their early development as a fetus.[5] Greater oxygen tension and increased circulating PGE2 and prostacyclin (PGI2) in full-term neonates cause it to shut completely within 24-72 hours.[5] In some patients, particularly preterm infants, the duct could stay open for a longer period of time.[5,17,18] Clinical symptoms become less reliable than echocardiographic outcomes in most cases. The gold standard for detecting the existence of a patent ductus arteriosus to date is echocardiography. Bounding pulses, tachypnoea, tachycardia, a broad pulse pressure, and a systolic murmur are all common symptoms of PDA.[15] Wide pulse pressures, a distinctive coarse systolic murmur at the left sternal boundary, cardiac hypertrophy (as a symptom of systemic hypoperfusion compensation), and hypotension are the most typical symptoms of PDA.[5,17,19]

PDA has been treated with ibuprofen, indomethacin, and acetaminophen.[17,18] If they are hemodynamically significant, tiny and small PDAs should be sealed.[5,18,19] To address the PDA, surgical ligation, video assisted thoracoscopic surgical (VATS) interruption, and trans-catheter occlusion of PDAs are currently viable alternatives.[8,19] PDA closure can be done at any moment, primarily if heart failure or pulmonary compromise are present. However, due to the decreased risk profile at 6-12 months, kids who are asymptomatic should wait until they reached this particular age before they can undergo closure.[10]

2. Acyanotic heart disease

2.1. Tetralogy of Fallot

The most frequent cyanotic CHD is Tetralogy of Fallot, which affects 0.34 out of every 1,000 live infants.[20] A ventricular septal defect (VSD), overriding aorta, right ventricular (RV) outflow tract obstruction (RVOTO) which is often dynamic, and right ventricular hypertrophy (RVH) are the four cardinal characteristics of Tetralogy of Fallot.[21] A right-to-left shunt is possible with a VSD. Blood flow to the pulmonary circuit is restricted by the RVOTO. The presence of an overriding aorta permits more deoxygenated and oxygenated blood to enter the circulatory system. The additional workload required to circulate blood to the right ventricular blockage and the aorta obstructing the flow of blood causes right ventricle hypertrophy.[13,21]

A PDA may be needed by patients with Tetralogy of Fallot with severe RVOTO to provide adequate pulmonary blood flow; for instance a duct-dependent circulation necessitates prostaglandin infusion (either alprostadil [prostin E1] or dinoprostone [prostin E2]) until more temporizing palliative procedures or definitive surgical procedures can be performed.[18,19] If spelling occurs frequently in infants with dynamic RVOTO, beta-blockade (e.g. propranolol) may be required.[18] Patients with Tetralogy of Fallot and a large ventricular septal defect who are acyanotic will possibly develop a massive left-to-right shunt, which may necessitate the use of diuretics and may lead to heart attacks.[18]

Surgery is recommended for children whose saturation levels are below 80% or who have hypercyanotic spells.[5] When there is a significant stenosis or pulmonary valve atresia, surgical therapy may include palliative operations such as a modified Blalock-Taussig-Thomas (mBTT) shunt to assist in the provision of continuous pulmonary blood flow.[5] While waiting for a full repair as the infants grow, catheterization may help increase blood flow in the lungs.[5,21] Complete cardiac repair procedure is usually performed before the child reached the age of six months. The procedure includes closing the ventricular septal defect and septating the aorta back to the left ventricle, as well as the surgically removing the RVOT muscle bundles and reducing the degree of RVOT valvular stenosis. This results in normal saturations.[5,18]

Nutrition status of congenital heart disease patients

Malnutrition is described as a discrepancy between dietary needs as well as consumption, causing cumulative calorie, protein, or micronutrient shortages which can have a deleterious impact on growth, development, and other outcomes.[5,21] The WHO advises that malnutrition be defined and classified using established concepts and categories

depending on the anthropometric indicators' computed Z scores. Moderate malnutrition is defined as a Z score of -≤ -2 SD for low WAZ (underweight), low WHZ (wasting) and, low HAZ (stunting), and severe malnutrition is described as a Z score of ≤-3 SD.[23] Malnutrition or nutritional deficiencies generally occurred in children with CHD due to a range of factors, such as lesser energy diet owing to the lack of food and poor nutrient uptakes from the digestive system, extra energy demands due to their cardiac and respiratory conditions as well as due to poor neurohumoral functions in CHD, or both.[21–23] Malnutrition in children with CHD can also be caused by chromosomal anomalies/genetic disorders, high blood pressure in the blood vessels that supply the lungs, as well as the age at presentation.[20–22]

Malnutrition is associated with adverse health outcomes in children with CHD, as indicated by regular admissions, poor surgical outcomes, permanent visceral development impairment, and higher death.[21] Children with cyanotic cardiovascular disease and pulmonary hypertension tend to have stunting, whereas those with acyanotic cardiovascular disease are likely to be wasted.[21,22,24]

Pre-operative phase

Corrective procedures for CHD are delayed in underdeveloped nations due to resource constraints, resulting in a never-ending phase of heart problems and respiratory disease. Malnutrition may be associated with other risk factors in developing countries compared with developing countries. Patients with CHD have a significant prevalence of nutritional deficiencies just prior to surgery. [25,27]

The prevalence of malnutrition was observed to be 84.0 % in patients with CHD in Egypt, according to Hassan et al.[28] Vaidyanathan et al.[29] found that 59.0 % of infants with CHD were malnourished prior to surgery in South India. Even before surgery, 23.3 % were underweight, 23.3 % were stunted, and 14.3 % were wasted, according to Zhang et al.[26]

Children with CHD who also had malnutrition have a higher risk of poor outcomes.[21,23,30,31] Stunted children had a higher risk for longer length-of-stay, longer period of mechanical ventilation, and required over three inotropes post-operatively, whereas children who were underweight were at a greater danger of 30-day mortality and respiratory failure.[26,30,31] A complete preoperative evaluation is recommended to provide crucial baseline data for evaluating progress after surgical correction. Accurate measurements of weight, height, and head circumference is typically needed.[20]

Strategies to increase nutritional balance in children with CHD include: (1) cautious reintroduction of high-calorie foods; (2) avoidance of excessive fluid loads; (3) salt restriction; and (4) electrolyte monitoring.[33]

Significant daily calorie multivitamin supplements in children with CHD contribute to enhanced growth and surgery outcomes, and interventions such as the introduction of calorie-rich foods, infant formula, protein additive or vitamins and minerals. In some cases, changing the technique of feeding, such as bolus or continuous enteral feeding via nasogastric, small bowel, or gastrostomy feeding, could also be used.[26,30]

The standard 75 to 120 kcal/kg/day requirements is needed to maintain caloric intake. Protein must account for 8-10% of caloric intake, with carbohydrate accounting for 35-65% and fat accounting for 35-50% (4% being essential fatty acids). Potassium balance is essential and should be provided due to anabolism, particularly if diuretics are used often. The daily dose is 2-3 mEq/kg, but in cases of acute depletion, it can be as high as 4-5 mEq/kg/day. Even if salt is reduced to prevent heart problems, at least 2-3 mEq/kg daily sodium intake is required. In children with CHD, urinary osmolarity should not surpass 400 mOsm/L.[33]

Post-operative phase

In the early days after surgery, patients require more energy, thus enteral feeds should be started after it is feasible, and parenteral nutrition should only be employed if definitely necessary.[26,39] A combination of genetic factors, multiplied metabolic needs, inadequate nutrient uptake due to ineffective gut function to obtain energy, postsurgical fluid restriction to avoid volume overload, oropharyngeal dysfunction, and interruptions of enteral feeding for procedures can make achieving adequate nutritional intake difficult.[27,32,]

Tabel 1. Summary of the correlation between pre-operative nutritional status and post-operative outcomes

References	Sample size (*n*)	Age-range	Variable	Outcomes	Results
Anderson et al.[34]	100	2-10 months	WAZ	– Hospital Length of Stay – Duration of mechanical ventilation – Chest tube duration	– Lower WAZ suggested a longer hospital Length of Stay
Anderson et al.[35]	55	18-72 months	WAZ	– Hospital Length of Stay – Duration of mechanical ventilation – Post-operative infections – Chest tube duration	– WAZ<−2 predicted a higher probability of severe postoperative infections, and severe postoperative infections predicted a longer stay in the hospital – The duration of the cardiopulmonary bypass predicts the duration of the mechanical ventilation.
Wallace et al.[36]	2,747	<6 years	Age Weight WAZ	– In-hospital mortality – Fontan failure* – Hospital Length-of-Stay – Complications	– WAZ <-2 predicted higher in-hospital mortality, – Fontan failure, and a longer hospital Length-of-Stay – Age and weight were not found to be significant predictors of outcome measures.
Mitting et al.[32]	248	<28 years	WAZ	– Hospital mortality – Mortality at 1 year – Duration of Mechanical/Non-invasive ventilation – ICU Length-of-Stay – Maximum lactate – Inotrope use	– Low WAZ predicted a longer combined mechanical ventilation and non-invasive ventilation duration and greater mortality at one year. – WAZ had no effect on the duration of the mechanical ventilation.
Marwali et al.[37]	249	5-36 months	WAZ	– ICU Length of Stay – Duration of mechanical ventilation	– Lower WAZ was linked to a longer ICU Length of Stay and mechanical ventilation length.

References	Sample size (*n*)	Age-range	Variable	Outcomes	Results
Ross et al.[38]	2,088	0-5 years	HAZ WAZ Weight for height Z-scores	– 30 Day-mortality – ICU Length of Stay – Hospital Length of Stay – Duration of mechanical ventilation – Infection cardiac arrest	– Every additional HAZ unit drop or WAZ ≤–2 was correlated with a 2.9 % or 2.1 percent higher risk of mortality in the range of HAZ or WAZ <-2 – Lower HAZ was also linked to an increased risk of infection, cardiac arrest, ICU admission, increased ventilation, and hospital Length of Stay. Lower WAZ was associated with an increased risk of infection, cardiac arrest, ICU Length of Stay, and mechanical ventilation.
Radman et al.[25]	71	<5 years	Triceps skinfold-for-age plasma BNP levels	– 30 day-mortality – ICU Length of Stay – Duration of Mechanical ventilation	Shorter ICU Length of Stay, mechanical ventilation times, dopamine infusion times, and milrinone infusion times were all connected to higher TSFZ levels. – Perioperative BNP levels predict outcome in a variety of illness situations, including prolonged length of mechanical ventilation and ICU admission of post-surgery for congenital heart abnormalities.

HAZ, Height-for-age z-score; ICU, Intensive care unit; WAZ, Weight-for-age z-score. *Fontan failure was a combination outcome, defined as either in-hospital mortality, Fontan takedown or revision.[30]

The most common concern with early feed initiation is the risk of poor cardiac output due to gut hypoperfusion, which can develop to necrotizing enterocolitis in infants with duct-dependent circulation.[26]

Feeds are generally triggered at 1 ml/kg/hour in newborns and young infants within 12–24 hours following surgery and increased at the same rate every 4 to 6 hours to attain the goal volume.[26] The maintenance fluid rate determines feed volume in the early post-operative phase. To attain a negative fluid balance, fluid intake is generally restricted.[37] The resting energy consumption in the first 3–5 days is expected to be 55–75 kcal/kg/day based on research in CHD patients. This helps guide initial feeding, which can be increased to 120–150 kcal/kg/day when transitioning to a lower level of care to facilitate catch-up growth.[26] Breast milk is the best source of nourishment for neonates and babies, especially in low- and middle-income countries (LMIC).[26,37]

In addition to breastmilk, new research suggests that protein- and energy-enriched infant formula (PE formulas) may aid in achieving nutrition goals and promoting anabolism in infants following cardiac surgery.[26,41] Scheeffer et al.[42] found that energy-enhanced formula is well tolerated after heart surgery in CHD patients and could help with short-term nutritional outcomes, minimizing hospital length-of-stay and the use of antibiotics. In newborns, PE milk is well-tolerated by infants with congenital heart surgery and is helpful in attaining higher nutritional intake even in the first days after surgery, according to Cui et al.[43]

A study conducted in developed countries found that two years following surgery, catch-up growth is essentially complete.[27] However, another study found that at the third year after surgery, numerous children remain malnourished (1.9 % wasting, 2.7 % stunting, and 3.2 % underweight).[26]

Conclusion

One of the most common human developmental anomaly is congenital heart disease, which in children is frequently associated with malnutrition and failure-to-thrive. Growth failure has been linked to higher morbidity and mortality in children with CHD. To avoid unfavorable outcomes, nutritional management is required both before and after surgery. Human breast milk is the best nourishment for children with CHD. Protein- and energy-enriched formulas, in addition to human breast milk, can help children with CHD who are undergoing surgery have a better outcome.

Conflict of Interest

Authors declared no conflict of interest regarding this article.

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ORIGINAL PAPER

Medical nutrition therapy in chronic pancreatitis

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Abstract

Chronic pancreatitis is a complex disease associated with significant morbidity and mortality. Patients with chronic pancreatitis are at risk for malnutrition and nutrient deficiency caused primarily by malabsorption, inadequate intake, and inflammation. Poor nutritional status may negatively affect disease's outcome. Medical nutrition therapy which include screening and assessment of malnutrition followed by optimal nutritional intervention for patient at risk should be the cornerstone of chronic pancreatitis multidisciplinary treatment. The dietary recommendation for malnourished chronic pancreatitis patients is high-calorie, high-protein, and low-fiber diet delivered in small frequent meals. Oral nutritional supplements, enteral, and/or parenteral nutrition should be considered respectively in the setting of failed oral nutritional intake to meet the energy and protein requirement.

Keywords: nutrition therapy, chronic pancreatitis, malnutrition, malabsorption

Introduction

The accelerated development in medicine still could not solve pancreatic problems such as inflammation, which is to date, difficult to treat.[1] Chronic pancreatitis occurs when there are recurrent inflammation episodes followed by the development of scar tissues, creating irreversible damages and pancreatic insufficiency that could potentially cause weight loss, malnutrition, diabetes, and other metabolic disturbances.[1–3] Globally, the prevalence of chronic pancreatitis is around 50 per 100,000 individuals, with an annual incidence of 5-12 per 100,000 individuals. The demographic distribution shows that higher numbers of chronic pancreatitis occur in tropical regions such as South India with 25-125 cases per 100,000 individuals.[4]

The consistency in managing pancreatitis is still puzzling as there are no effective treatments discovered. Generally, pancreatitis treatment is supportive, with nutrition as the main pillar aimed to prevent disease's progressivity.[2] To this day, there has not been enough data to support optimal medical nutrition therapy for patients with chronic pancreatitis. Administering any dietary composition for chronic pancreatitis remain controversial, as questions arise between the use of balanced or low-fat diet, long or medium-chain triglycerides

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selection, adding or eliminating fibers, and the timing of micronutrient supplement administration. The variety of nutrition therapy on chronic pancreatitis is apparent in everyday practices, and therefore requires discourse in the administration of nutrient management based on evidence and available scientific data. The aim of this review is to highlight the optimal nutrition therapy for chronic pancreatitis based on current studies and recommendations.

Chronic Pancreatitis

Chronic pancreatitis is a collection of symptoms that is the result of progressive chronic inflammation on the pancreas, followed by fibrosis and scar tissues, resulting in the irreversible damage and loss of exocrine and endocrine cells.[5] Although it is triggered by different risk factors, supporting data suggest that acute pancreatitis, recurrent acute pancreatitis, and chronic pancreatitis are one continuity of a disease. The TIGAR-O classification system groups the risk factors to intertwine among toxic-metabolic, idiopathic, genetic, auto-immune, heavy acute and recurrent pancreatitis, and obstruction as the causes of chronic pancreatitis. In most cases, there are more than one etiology.[6]

Damages on acinar cells in alcohol-induced pancreatitis is caused by the metabolite, acetaldehyde. Smoking produces toxic metabolite nitrosamine ketone that can also damage the acinar cell. Mutation and genetic vulnerability correlate with the pancreatic defensive mechanism dysfunction against autodigestive processes. An intracellular trypsin activation triggers cascading inflammation, oxidative stress, and acinar autophagy disruption. The pancreatic stellate cells activation plays a role in chronic inflammation and fibrosis in acute pancreatitis.[7] The history of acute pancreatitis and other risk factors can trigger the activation of the immune system that can either heal or progress to chronic pancreatitis.[6]

Different from acute pancreatitis, chronic pancreatitis continues in several years. The main clinical manifestation is recurrent pain on the epigastrium spreading to the back, with food as the trigger for exacerbation in 80% of chronic pancreatitis patients.[7] Other symptoms such as nausea, vomiting, diarrhea, steatorrhea, and fatigue hinder patients from maintaining adequate nutrition.[8] Complications of chronic pancreatitis can result in glucose intolerance, gastrointestinal bleeding, jaundice, cholestasis, and biliary cirrhosis. Twenty years following chronic pancreatitis diagnosis, the cumulative risk towards pancreatic carcinoma is at 4%.[5]

The diagnosis of chronic pancreatitis is established using CT-Scan or MRI. The depiction of heavy chronic pancreatitis is marked by pancreatic calcification, atrophy, and dilating or irregular ductus. The combination of endoscopic ultrasound and pancreatic function tests used to detect chronic pancreatitis at the early stage are often inaccurate and difficult to do given there are no specific biomarkers to look for.[6] Blood pancreatic enzymes can be normal or slightly elevated in chronic pancreatitis. Elevation in bilirubin serum and alkaline phosphatase can indicate secondary cholestasis due to common bile duct stricture on chronic inflammation. Glucose intolerance can also be indicated by the increase of fasting blood sugar level. Faecal elastase, pancreas' specific enzyme that does not degrade during transport in the gut, and jejunum biopsy can be used to evaluate patients with steatorrhea suspected as the result of pancreatitis.[5]

Chronic pancreatitis treatment involves modifying lifestyle that relates to the exacerbation of the disease, such as alcohol consumption and smoking, pain management, restoration of digestive and absorption functions, and overcoming endocrine insufficiency.[3] As many as 30% of patients with chronic pancreatitis require endoscopic therapy and/or surgery. Resection procedure or drainage to manage pancreatic duct obstruction due to stones, stricture or both can reduce intraductal pressure and abdominal pain.[7]

Nutritional aspects

Patients with chronic pancreatitis are at high risk of experiencing malnutrition due to pancreatic insufficiency and inadequate food intake. Other nutritional problems encountered in chronic pancreatitis include altered gastrointestinal function, recurrent abdominal pain that causes suboptimal food intake, increased resting energy expenditure

(REE) and protein requirements, impaired energy utilization, as well as excessive alcohol consumption.[2,9]

Malnutrition is often found in the advanced stages of chronic pancreatitis and is influenced by the severity, duration, and underlying cause of the disease. Loss of body weight and fat-free mass in chronic pancreatitis patients, as well as sarcopenia, will lead to decreased functional capacity and quality of life. Sarcopenia is found in 17% of patients with chronic pancreatitis and is associated with a higher risk of hospital admission. The presence of pancreatic exocrine insufficiency (PEI) also increases the risk of bone loss and osteoporosis.[2]

Pancreatic exocrine insufficiency in pancreatitis characterized by maldigestion and malabsorption of macro and micronutrients from insufficient secretion of pancreatic enzymes and bicarbonate.[10] Symptomatic PEI manifests if 90% of pancreatic exocrine function is lost. Severe PEI develop between 5–10 years from the initial diagnosis in 50% chronic pancreatitis patients. Low levels fecal elastase (<200 μg/g stool) is often used to detect PEI.[6]

Diabetes mellitus (DM) type 3c or pancreatogenic diabetes is a complication that occurs in 30-50% of cases of chronic pancreatitis. Damage and loss of endocrine cell function in islet of Langerhans as a consequence of microvascular ischemia decreases the secretion of insulin and glucagon hormones which results in instability of blood glucose levels, so that patients can experience episodes of hyperglycemia or hypoglycemia. Hypoglycemia predominantly can result from malabsorption, decreased intake, and damage to pancreatic alpha cells.[11]

Non-alcoholic fatty liver disease (NAFLD) is a complication of chronic pancreatitis that often goes undetected. The mechanism underlying the occurrence of NAFLD is related to the malabsorption of essential amino acids, such as choline, which causes a decrease in plasma concentrations of apoprotein B, the main component of VLDL.[2]

Deficiency of vitamins A, D, E, and K correlates with the severity of steatorrhea in chronic pancreatitis, although it also can be caused by other mechanisms, such as inadequate intake, increased requirement, and high antioxidant activity.[9,10] In chronic pancreatitis, the prevalence of vitamin A, D, E, and K deficiency are 3–14.5%, 58–77.9%, 9–24%, and 13–63%, respectively. Vitamin A deficiency with clinical manifestations of night blindness has been reported in some cases of chronic pancreatitis. Secondary thiamine deficiency may be considered in alcoholic pancreatitis. In addition, PEI can also cause deficiency of folic acid, zinc, selenium, and iron.[2] The protease enzymes needed to release cyanocobalamin so that it can be absorbed in the terminal ileum have decreased secretions which in the long run lead to vitamin B12 deficiency.[9]

Osteopathy, including osteoporosis, osteopenia, and osteomalacia, is found in at least 25% of cases of chronic pancreatitis and is associated with malabsorption of vitamin D and calcium.[9] However, in several studies, there was no direct relationship between serum vitamin D levels and low bone mineral density. Other factors that are thought to be involved in bone demineralization are smoking, low physical activity, and chronic inflammation in pancreatitis.[2]

Nutritional assessment

Nutritional assessment is carried out through a multi-disciplinary approach, including clinical symptoms, organ function, anthropometry, and biochemical examinations.[9] The method of assessing nutritional status based on body mass index (BMI) alone is considered inadequate to predict a decrease in muscle mass and functional status. Percentage of weight loss is rated as a better indicator of malnutrition and is associated with an increased risk of surgery for chronic pancreatitis. Sarcopenia in pancreatitis is associated with increased rate of hospitalization and mortality. Nutritional assessments should detect malnutrition, sarcopenia, and micronutrient deficiencies, and identify symptoms that have the potential to cause malnutrition.[2] Routine anthropometric assessment in chronic pancreatitis patients should include weight changes, BMI, body composition, and handgrip strength.[12]

Macro and micronutrient deficiency screening is performed every 12 months or more frequently for severe chronic pancreatitis with uncontrolled malabsorption. Routine screening forms the basis for determining which nutritional interventions should be given. Clinical symptoms of nutrient deficiency are difficult to find early in the disease, therefore routine screening are needed to detect early signs of deficiency. Chronic pancreatitis with PEI and malabsorption manifests in altered body composition and decreased markers of nutritional biochemical status, such as albumin, cholinesterase, prealbumin, retinol-binding protein, and magnesium.[2]

Dual-energy X-ray absorptiometry (DXA) can be used to identify chronic pancreatitis patients with osteopathy, especially in high-risk groups. Based on the recommendations, the group of patients at high risk of osteopathy are postmenopausal women, men over 50 years of age, a history of fractures due to minor trauma, and malabsorption. In patients with osteopenia, DXA examinations should be performed periodically every two years.[11]

Medical Nutrition Therapy

The main objective of medical nutrition therapy is to provide optimal nutritional support and reduce pain by minimizing exocrine stimulation of the pancreas. If post-prandial pain is a limiting factor for intake, administration of enteral nutrition therapy with minimal effect on elevated CCK levels may be an alternative. Nutritional counselling, administration of antioxidants, and pancreatic enzymes have a role in the effective management of chronic pancreatitis.[8]

Patients with chronic pancreatitis do not need dietary restrictions especially regarding fat intake, unless accompanied by symptoms of uncontrolled steatorrhea. A balanced diet is consistently recommended in patients of normal nutritional status. In patients with chronic pancreatitis and malnutrition, administration of 33% of energy derived from fat was well tolerated, and had an effect on improving nutritional status and pain control. The provision of a diet high in protein and energy in 5–6 small meals a day is also recommended in this patient group.[2] Calorie needs are estimated to be up to 35 kcal/kg/day, with optimal protein administration of 1–1.5 g/kg/day and fat of 0.7–1 g/kg/day.[13] On the other hand, high fiber consumption should be avoided because it is associated with worsening symptoms of flatulence and steatorrhea, and may interfere with pancreatic enzyme replacement therapy (PERT).[2]

As many as 20% of cases of chronic pancreatitis require oral nutritional supplementation (ONS) which is indicated in malnourished patients who are unable to meet the target calorie and protein needs through oral intake. In the presence of PEI, enteral formulas containing hydrolyzed nutrient components and a mixture of long-chain triglycerides (LCT) and medium-chain triglycerides (MCT) can be useful, because MCT absorption does not depend on lipase activity. However, substitution of fat in the diet with MCT has the potential to reduce energy intake due to its side effects, such as nausea and diarrhea. In patients treated with PERT, the use of the MCT formula was not considered superior to LCT.[2]

In general, dietary counselling and ONS administration are sufficient to improve the nutritional status of most patients with chronic pancreatitis. Enteral nutrition (EN) is indicated in 5% of malnourished patients who do not respond to ONS. Enteral nutrition therapy should be administered via the nasojejunal tube in patients with abdominal pain, delayed gastric emptying, persistent nausea and vomiting, and gastric outlet obstruction (GOO). Long-term jejunostomy access, percutaneous endoscopic gastrostomy with jejunal extension, direct percutaneous endoscopic jejunostomy, or surgical jejunostomy can be used when administering EN for more than 30 days. Semi-elemental formulas with MCT content can be selected if the standard formula cannot be tolerated. Pancreatic enzyme supplementation with EN should be given to patients with signs of exocrine failure.[2]

Another important benefit of EN is the maintenance of intestinal mucosal function and integrity. Parenteral nutrition (PN) is associated with an increased risk of hyperglycemia, infection, and sepsis, so it is only indicated in patients with GOO, complications of fistulas, or EN intolerance. The recommended route for PN administration is via central venous access.[2] If total PN is indicated, intravenous administration of lipids and glucose

should not exceed 1.5 g/kg and 5 mg/kg/min, respectively.[13]

Fat-soluble and water-soluble vitamins, such as vitamin B_{12}, folic acid, thiamine, as well as minerals such as magnesium, iron, selenium, and zinc need to be evaluated and supplemented if deficiency is proven clinically or biochemically. To prevent osteopathy in chronic pancreatitis, several approaches can be taken, such as adequate calcium and vitamin D administration, PERT if indicated, regular weight training, and avoidance of smoking and alcohol. In patients with osteopathy, 800 IU of vitamin D and 500–1000 mg of calcium daily supplementation are recommended.[2]

In chronic pancreatitis accompanied by PEI based on clinical diagnosis or investigation, it is recommended to initiate PERT. The goal of PERT is to improve symptoms of maldigestion and maintain body weight. Enteric-coated microsphere preparations protect the lipase, amylase, and protease enzymes mixture from gastric acid, so they can disintegrate at pH >5.5 in the duodenum. The efficacy of pancreatic enzyme supplements depends on the process of mixing enzymes and chemicals. The optimal timing of enzyme administration is during or after meals. The minimum dose of lipase is 20,000–50,000 PhU with large meals and half the dose with snacks. The efficacy of PERT can be evaluated through improvement of gastrointestinal symptoms and nutritional parameters, such as anthropometry and biochemistry markers. In patients who show no improvement, evaluation of pancreatic function by fecal fat excretion or breath test should be done. If there is still an inadequate clinical response, the PERT dose can be increased or accompanied by administration of proton pump inhibitor. If these methods fail, other causes of malabsorption such as small intestinal bacterial overgrowth should be ruled out.[2]

Dietary counselling plays an important role in disease management. Chronic manifestations of nausea and vomiting can be reduced by a number of methods, such as eating dry food, drinking water several hours before or after meals, small frequent feedings, and avoiding consumption of alcohol or foods that have the potential to produce gas. In patients with PEI, diet containing MCT can be consumed along with simple carbohydrates to reduce unpleasant taste. In patients with pancreatogenic DM, it is necessary to control carbohydrate intake to prevent hyperglycemia.[13]

Conclusion

Pancreatitis, characterized by chronic inflammation of the pancreas, is a prevalent disease associated with a significantly increased risk of malnutrition. Several mechanisms that occur due to inflammation and dysfunction of the pancreas underlie the changes in metabolism and nutritional status of patients with pancreatitis. A comprehensive nutritional assessment performed in a patient with pancreatitis can form the basis for a comprehensive management decision. Medical nutrition therapy is a vital component in the management of chronic pancreatitis which focuses on providing proper and optimal nutrition, both macro and micronutrients to increase food intake, reduce symptoms of pain and malabsorption, and prevent further damage to the pancreas.

Conflict of Interest

Authors declared no conflict of interest regarding this article.

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ORIGINAL PAPER

The role of medical nutrition therapy on nutritional status, functional capacity and quality of life of pulmonary tuberculosis patients with difficulty

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Abstract

Pulmonary tuberculosis (pulmonary TB) is a chronic infectious disease with high levels of morbidity and mortality. Metabolic changes due to tuberculosis *Mycobacterium* infection and activation of the neurohormonal system contribute to the occurrence of malnutrition, which can have a negative effect on the prognosis of patients with pulmonary TB, as well as decreased functional capacity and quality of life. The provision of medical nutrition therapy from the beginning of diagnosis is upheld, supporting the recovery process of TB patients. In this series of cases, there were four cases of pulmonary TB patients with difficulty, namely TB billion, chronic obstructive pulmonary disease (COPD), and meningitis TB. At the beginning of the examination, there was a deficiency of macronutrients and micronutrients, hypoalbuminemia, anemia, and decreased functional capacity and quality of life. Medical nutrition therapy is administered individually, according to clinical conditions such as TB with mild, moderate and severe malnutrition, those are gradually weight loss and muscle wasting when the symptoms start until treated in intensive care unit (ICU) and hospital ward. According to laboratory parameters such as anemia, hypoalbuminemia, and a history of food intake analysis such as hypocaloric and starvation.

Keywords: pulmonary TB, malnutrition, medical nutrition therapy, quality of life

Introduction

Based on World Health Organization (WHO) data in 2016, there are an estimated 10.4 million tb cases worldwide, with 1.3 million deaths.[1] According to data from the Ministry of Health of the Republic of Indonesia, Indonesia is the country with the second most TB patients in the world after India. In Indonesia there are an estimated 429,730 new cases of TB, with 62,246 deaths. Incidence of acid-resistant bacterial TB (BTA) cases was positive at 102 per 100,000 inhabitants.[2] Research shows a link between TB and malnutrition. Hsin-Haos Lai et al.[3] research showed that 67% of TB patients have body mass index (BMI) less than 18.5 kg/m^2 and happen in men. Semba et al.[4] showed that malnutrition can increase the risk of developing TB infection by 3.2

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times.[4] Patients with active pulmonary TB accompanied by malnutrition need appropriate nutritional interventions.[5] In table 1 we can see the summarized of some cases.

Table 1. Serial case summary

Variable	Case 1	Case 2	Case 3	Case 4
Male	Male	Male	Male	Male
Age	37 years old	49 years old	74 years old	22 years old
Education	Elementary school	Elementary school	High junior school	High junior school
Risk factors	smoker, alcohol, pollutan, poor ventilation	smoker, alcohol, Type 2 DM, pollutan	smoker,alcohol, MG	smoker, pollutan, poor ventilation
Clinical diagnosis	TB billion, lymphadenitis, multipel TB	ARDS, meningitis TB, pulmonary TB, Type 2 DM	ARDS, COPD et causa pneumonia, pulmonary TB	Pleura TB
BMI (kg/m^2)	13,6	16,8	22,2	17
Weight loss	20 kg in 4 months (33%)	15 kg in 4 months (27%)	unknown	6 kg in 1 month (12%)
Nutritional status	Severe malnutrition	Moderate malnutrition	Clinically appropriate malnutrition (ASPEN criteria)	Moderate malnutrition
Duration of treatment	6 days	6 days	9 days	6 days
Complaints	Tightness, chronic cough, neck lumps, fatique, night sweats	Decreased consciousness,chronic cough, headache, stiff neck, vomiting, fever	Tightness, fever, vomiting, chronic cough	Tightness, cough
Examination of physic	ronchi, wheezing, xylophone ribs, muscle wasting	ronchi, wheezing, xylophone ribs, muscle wasting, edema dorsum pedis	ronchi, wheezing, muscle wasting	ronchi, wheezing, muscle wasting
Laboratory	Anemia, hypoalbuminemia, hypocalcemia, increased CRP, Gen x-pert positive	Anemia, hypoalbuminemia, increased CRP, positive BTA	Leukosytosis, hypocalsemia, metabolrespiratory acidosis, increased CRP, positive BTA	Leukosytosis, increased CRP, negative BTA
Photosnof plain chest	TB billion, right pleural effusion	TB duplex pulmonary	Ex-TB pulmonary duplex	TB pulmonary, right pleural effusion
Nutritional achievement during treatment	135% TEE	REE	TEE	80% TEE
Micronutrients	B1, B6, folic acid, C, A, D, E, zinc	B1, B6, folic acid, C, A, D, E, zinc	B1, B6, folic acid, C, A, D, E, zinc	B1, B6, folic acid, C, A, D, E, zinc

Table 1. Serial case summary

Variable	Case 1	Case 2	Case 3	Case 4
Specific nutrients	Omega-3	Omega-3	Omega-3	Omega-3
Functional capacity (KPS score)	30 → 80	10 → 10	20 → 60	30 → 90
Specific nutrients	MUFA	MUFA	MUFA	MUFA
Quality of life (SF-36 score)	15 → 85	5 → 5	30 → 70	20 → 90
Clinical Outsider	Return home	died	Return home	Return home

Description : ARDS (acute respiratory distress syndrome*)*; ASPEN (The American Society for Parenteral and Enteral Nutrition); BTA (acid-resistant basil); CRP *(C-reactive protein);* DM (diabetes mellitus); BMI (Body mass index); REE (Resting Energy Expenditure); TEE (Total Energy Expenditure); MG (myasthenia gravis*);* COPD (chronic obstructive pulmonary disease); TB (tuberculosis).

Diagnosis

Diagnosis in all four patients was found based on anamnesis, weight change, history of intake analysis, physical examination, supporting examination such as BTA sputum, laboratory, and radiology. The findings of the examination in all four patients had been malnourished before the clinical symptomps appears. This makes their condition difficult when they has chronic *Mycobacterium tuberculosis* infections. In their cases we found long duration of coughs more than 2 weeks, decreased weight, fatigue, decreased appetite, smoking and drinking habits as well as low levels of education. Two patients had DM comorbidity and myasthenia gravis (MG) which made the conditions of patients with TB infections relatively more difficult to control.

The four patients came from low socioeconomic, dense environment, and poor residential ventilation, as well as contact with family/workmates and neighbours who had a history of chronic cough and TB, and had difficulty in obtaining a healthy diet with balanced nutrition according to the patient's energy needs due to low socioeconomic and lack of knowledge about balanced nutrition and management. These four cases experienced limited food intake and excessive workload leading to fall into a state of malnutrition. Based on nutrisurvey analysis data before illness, the first, second , and fourth patients showed the total energy intake, amount of protein and percentage of fat and protein are low compared to basal energy needs and the total needs of patients.

The four cases of malnutrition according to ASPEN criteria are: decreasing in energy intake before illness in at least one month, weight loss more than 7.5% in one month or >10% within six months, decreasing in subcutaneous fat mass and decreased muscle mass in the temples, clavicle, acromion, a mild pitting edema, and reduction in functional status.[6]

The second and third case patients entered the ICU because they were identified as having experienced type 1 respiratory failure. For the second patient due to chronic cardiorespiratory disorders (in the form of shortness of breath due to TB) which is aggravated by uncontrolled hyperglycemia in DM to sepsis that manifests also into the nervous system of the brain becomes meningitis TB. The third case patient suffered type 1 respiratory failure, caused by CO_2 intoxication resulting failure of the cardiorespiratory system as a consequence of impairment compliance, ventilation and pulmonary diffusion as a process of recurrent MG disease and lesions of the respiratory muscles.[7]

Governance

Based on WHO recommendations, nutrition management in TB is an assessment of the nutritional status of patients, nutrition education,

malnutrition management, and micronutrients supplementation.[9,10] Recommendations for nutrition in patients with pulmonary TB ranging from 25–30 kcal / kg BW / day. Calorie calculation is recommended using dry weight. Nutrition provision might gradually increase of 10–20% up to the total energy needs for 7 days. Basal energy need is calculated using the Harris-Benedict formula, the calculation results are then multiplied by stress factors to obtain total energy needs. Stress factors used by 1.3–1.5 are adjusted to the state of hypermetabolism experienced by the patient especially there is a difference when the patient is in critical condition in intensive care and hospitalized. WHO recommends providing nutrition with a balanced composition, namely protein 15-20%, fat 25-35% and carbohydrates 45-60%.[6]

Solutions to improve pulmonary power in patients in the second and third cases are obtained from the mechanical ventilation process by adjusting the ventilator mode used and gradually lowered from the PC ventilator mode to PSIMV until the ventilator machine is removed, and takipneu that has been overcome. Nutrition is given gradually starting from 80% hich is 900 kcal energy (18 kcal/Kg BW/day) with protein of 0.8 grams/kg BW/day. The provision of nutrition to these patients in accordance with the recommendations of ESPEN 2018 and ASPEN 2016.[8,9] Other considerations were given 900 kcal because the food intake of four months before illness was 588 kcal in the form of regular meals to porridge, so the nutritional as increased by 20% in the form of liquid diet via tube feeding.

Protein intake in the second case begins with 0.8 g/kg/day, with nitrogen to non calorie protein ratio = 1/100 derived from animal protein diebetes liquid formula 3x100 ml, 3x150 ml increases gradually to 200 ml, 1-3 egg whites, as well as grains are given in fruit juice mixture. The administration of final proteins in stable patients such as the first, third and fourth cases according to the guidelines reaches 20% of total energy expenditure (TEE). Fat is given as much as 30% of TEE, in accordance with WHO recommendations, fat administration of 25-35% with the composition of fat types as recommended, namely saturated fatty acids (SAFA) <7%, polyunsaturated fatty acids (PUFA) ≤10%, and monounsaturated fatty acids (MUFA) ≤15%. Carbohydrates are recommended at 45–60% TEE. From the data of the four patients obtained from the analysis of intake when sick, it appears that the composition is less MUFA and omega-3 of PUFA, so that in the second case patients added omega-3 specific nutrients and additional MUFA content that is useful to support TB recovery and reactive hyperglycemia control that occurs in sepsis with DM.[10] Selected liquid foods in the form of commercial diabetes formula / diabetes liquid to control reactive hyperglycemia that occurs. Preferred commercial diabetes formula with consideration of fiber content is higher than diabetes liquid, which is 4 dietary fiber per 260 mL commercial diabetes formula compared to 1.7 grams per 260 ml diabetes liquid.

The results of analysis of the intake of four patients before illness and during treatment showed a lack of micronutrients intake compared to daily intake needs, so that micronutrients can be given as supplementation in the form of vitamin B1, B6, folic acid, C, A, D, E, zinc.[11,12] Post-treatment, based on the results of nutrisurvey analysis of the four patients before illness was seen macronutrients and micronutrients and specific nutrients insufficient daily intake needs, then given micronutrients supplementation namely Renovit® and omega-3 capsules and support from commercial omega-3 liquid diet to support the recovery phase of TB patients. Liquid diet selection is because it contains EPA of 1 gram per bottle (200 mL).

Result, monitoring and outcome

Three out of four patients experienced increasing calories of daily intake, improved clinical condition, functional capacity (based on KPS score), as well as quality of life (based on patient SF-36 score). The nutritional status of the patient does not worsen during treatment. All three patients had a good level of adherence to TB therapy and given medical nutrition therapy. One case died during treatment.

During six days of monitoring, three patients showed good results, it can be seen that there is an increase in appetite that meets the needs of daily

brain glucose levels, so that it can accelerate the non-dependence on ventilator use in the isolation ICU. So that patients can be discharged on days 6 and 9 with a target of nutrition achieved at least 80% total energy needs (TEE) and showed improvements in quality of life and functional capacity from heavy to light dependency. In some patients also experienced improvements from laboratory results on albumin, CRP, and hemoglobin. Unless there is one patient with TB meningitis accompanied by a history of uncontrolled DM with a history of alcohol drinkers, it worsens on the sixth day of treatment after two days off the ventilator machine, from the isolation ICU room moved to the isolation ward.

Discussion

Malnutrition can lead in lowering body's immunity, increasing susceptibility to infection, and increasing the severity of infection. On the contrary, TB is the cause of malnutrition, caused by low food intake, absorption disorders of nutrients in the intestine, increased basal metabolic requirements, increased protein catabolism processes, and increased need for specific nutrients due to infection.[13]

Increased energy needs can be caused by a state of hypercatabolism, which play a role in the occurrence of malnutrition in these pulmonary TB patients. Malnutrition in pulmonary TB can also be associated with low appetite that can affect the inadequate macronutrients and micronutrients intake. This conditions also accompanied by hypercatabolic conditions, resulting in worsened malnutrition which accompanied with anemia, hypoalbuminemia, muscle wasting, and other clinical symptom.[13]

Animal to plants protein ratio by 2:1 with consideration in that animals has a higher biological value than plant proteins. Moreover, in the most of TB patients have chronic anemia that requires absorption of amino acids in the gastrointestinal tract more optimally. Combined animal and plant proteins for optimal nutritional balance. This balance is also important in controlling excessive amounts of iron. Iron is still needed in nutritional medical therapy, but excessive amounts or ferroptosis might increase the number of necrotic cells due to macrophags infected with *Mycobacterium tuberculosis* that undergo lipid peroxidation and are affected by the work of GSH and Gpx4 levels.[14]

The selection of higher levels of dietary fiber in order to reduce the glycemic index is expected to maintain blood glucose level and increase insulin sensitivity.[15] In the diet prescription from the second case patients added with 5–10 grams (1–2 teaspoons) of olive oil as a source of MUFA that plays a role in controlling the blood glucose levels.[10] During clinical monitoring it is also showed a decrease in oxygen fraction in ventilator use. This indicates that the appropriate provision of nutrients does not burden the patient's condition, but accelerates the patient's recovery for weaning.[16] In the case of ventilator use in the second and third patients are given energy gradually to meet their basal needs, so that the acceleration of weaning from the ventilator can be achieved.

The function of vitamin B complex, B12, and folic acid is to inhibit the formation of homocysteine. Homocysteine can exacerbate endothelial damage, increase low density lipoprotein (LDL) oxidation, increase monocyte adhesion to the endothelial wall, increase the risk of thrombosis due to clotting disorders or platelet dysfunction, and decrease the nitric oxide response. Patients also administered an antioxidant vitamin C that play role to inhibit the oxidation of LDL, and decreases the production of nitric oxide to dilate blood vessels.[17] One of vitamin D function which associated with immunity support is it has antimicrobial response in the form of autophagy, fagolisomal, cathelicidin activation that eradicates *Mycobacterium tuberculosis*.[11,12]

Micronutrients play an important role in individuals with TB.[12] Systematic review conducted by Sinclair et al.[5] showed that individuals with active pulmonary TB who received vitamin A, D, zinc, selenium, B, and C supplementation during TB therapy had more BW enhancements than those who did not receive supplementation.[12] Junaid et al.[11] explained that further research is needed on vitamin D supplementation with the right dose to support the recovery of lung TB patients.[11] Vitamin and mineral supplementation recommended in TB is 50-150% of the number nutritional adequacy.[12] In TB there is an

increased need for micronutrients that cannot be obtained only from feeding.[6,12] Nutritional therapy in TB can accelerate the healing process of the disease by improving the immune system, increasing weight, strengthening muscles including respiratory muscles and pulmonary parenchymal tissue and improving the quality of life of patients and reducing the length of hospitalization, which can be assessed by improving the functional capacity and quality of life of patients.[6,12,17]

Rehabilitation and education are also recommended in TB patients to control the routine muscle function and functional capacity of the body, and it is recommended to follow a healthy lifestyle with optimal consumption of a balanced diet, to accelerate recovery. Some nutritional guidelines that are worth recommending to patients are following WHO recommendations.[6] Nutrition for TB patients is characterized by multiplying antioxidant substances and intake of specific nutrients such as vegetables, fruits, whole grains, legumes, and canola oil which is one of the sources of omega-3 by 11% with MUFA content of 65% and olive oil which is a source of MUFA 75% which also has omega-3 content but by 1%, as well as supplementation of micronutrients and omega-3.[5,6,12]

Conclusion

The treatment of medical therapy nutrition in TB patients depends on the difficulty and clinical condition of the patient. Total energy, percentage of proteins, fats and carbohydrates are adjusted to recommendations and clinical conditions. The administration of proteins is adapted to the function of the kidneys and hypercatabolic state, as well as clinical patients. Increased micronutrients need in TB patients were associated with poor intake, increased need for disease, and socioeconomic ability and side effects of anti-tuberculosis drugs. Micronutrients supplementation of vitamin B1, B6, folic acid, C, A, D, E, zinc according to recommended dietary allowances (RDA) and omega-3 specific nutrients with EPA 1 gram / day helps accelerate the recovery period of TB patients. The functional capacity of all three patients improved during treatment. After getting proper medical therapy nutrition, the situation is getting better until it recovers.

Conflict of Interest

Authors declared no conflict of interest regarding this article.

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ORIGINAL PAPER

Factors associated with physical inactivity among community dwelling adults in Umuahia, Nigeria

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Abstract

Background: Considerable evidence suggests that physical inactivity contributes to the magnitude of non-communicable diseases (NCDs) and is responsible for premature deaths globally.

Objective: This study aimed to examine physical inactivity and associated factors among community dwelling adults in Abia State, Nigeria.

Methods: A total of 868 community-dwelling adults (20 to 59 years) were sampled in a cross-sectional survey using multistage sampling technique. A validated questionnaire was used to collect information on sociodemographic and lifestyle characteristics. Weight and height were measured and used to calculate the body mass index (BMI). The Global Physical Activity Questionnaire (GPAQ) was used to collect data on physical activity status. Univariate and multivariate logistic regression were used to assess the relationship between physical inactivity and associated factors at $p<0.05$.

Results: The prevalence of physical inactivity was 49.8% (48.5% in males and 51.0% in females), while combined overweight and obesity was 39.4%. In the adjusted model, physical inactivity was associated with older age (OR=0.49, 95% CI: 0.34- 0.71), increasing BMI (OR=0.67, 95% CI: 0.49-0.91), increasing income (OR=0.65, 95% CI: 0.48- 0.89), and alcohol consumption (OR=0.67, 95% CI: 0.47- 0.97).

Conclusion: The high prevalence of physical inactivity among adults underscores the need for community-based physical activity interventions to reduce the burden of NCDs among adults.

Keywords: physical inactivity, prevalence, risk factors, community, adults

Introduction

Physical inactivity, is ranked as the fourth leading cause of death in low- and middle-income countries.[1] Considerable evidence suggests that physical inactivity is responsible for approximately 3.2 million (over 9%) premature deaths globally[1] and contributes to the magnitude of non-communicable diseases (NCDs). Globally, physical inactivity is reported to contribute to 21% of breast cancer, 27% of diabetes and 30% of ischemic heart diseases[2], with the World Health Organisation estimating about three million physical inactivity-related deaths in 2014 in Sub Saharan Africa.[3] In Nigeria 6.8% of adults older than 40 years are diabetic, 8.8% are obese[4] and 31% are hypertensive.[5] In addition, the increasing morbidity and premature mortality rate caused by physical inactivity is also responsible for substantial economic burden worldwide.[6]

Different tools have been used to measure physical activity status.[7] For instance, in population based surveys, it is necessary to use a valid instrument, which is relatively cheap and has easy application in order to allow for comparison among surveys conducted in different localities.[7]

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The Global Physical Activity Questionnaire (GPAQ) or International Physical Activity Questionnaire (IPAQ) is a commonly used tool. These questionnaires were proposed by the World Health Organisation (WHO), with the objective of making available a tool for measuring physical activity levels, that could easily be adapted in different regions and culture.[7]

The WHO health report of 2000, indicated that 17.7% of the global population (aged 15 years and above) were not engaged in any kind of physical activity. The report also showed that nearly 58% of adults were not achieving the recommended number of moderate-intensity activities to be considered physically active.[8] As a result, WHO recommended that adults should engage in at least 150 minutes of moderate (MPA) to 75 minutes of vigorous physical activity (VPA) per week, respectively, or an equivalent combination of moderate to vigorous physical activity (MVPA) throughout the week.[9] This is equivalent to an energy expenditure of more than 600 Metabolic Equivalent of Task-minutes per week (MET-minutes per week) and is considered as sufficient physical activity, while less than 600 METS minutes per week is considered physically inactive.[9]

Globally, physical inactivity is reported to be prevalent in many countries.[1] For instance, the prevalence of physical inactivity was 79%, 56.2%, 43.7% and 43.3% in Saudi Arabia, China, Malaysia, and Nepal, respectively.[10,11] A high prevalence of physical inactivity has also been reported in African countries with 60.5%, 53.2%, and 31.4% in South Africa, Mali, and Nigeria, respectively[12], thus indicating the burden is on the increase in many countries.[1,12] The nutrition transition, accompanied by rapid urbanization, unhealthy diet, and changes in work patterns have contributed to physical inactivity particularly among adults in developing countries.[13] In addition, physical inactivity is reported to be associated with other risk factors such as age, place of residence, sex, body mass index, alcohol consumption, cigarette smoking, educational status and economic status.[13,14,15,16]

Nigeria is a low-middle income country undergoing rapid nutrition and epidemiologic transition.[12,16] It has an estimated population of over 200 million, which is the highest in Africa and perhaps includes the highest population of physically inactive persons on the continent.[17] The prevalence of physical inactivity is reported to be high in Nigeria, ranging from 25% to 57%, with this linked to a higher prevalence of obesity, type 2 diabetes and cancer.[4,18] In a systematic review and meta-analysis, it was estimated that about 50 million persons in Nigeria are physically inactivity on a weekly basis representing an age-adjusted prevalence of 58%. Comparison of physical inactivity levels across the geopolitical regions showed that the South-east zone had the highest prevalence (63.3%), compared with the South-west (40.8%) and South-south regions (57.7%).[17] However, most studies assessing physical inactivity focused on urban adults with limited information among community-dwelling adults in both urban and rural areas. Information from community dwelling adults will provide insights into targeted interventions that will help reduce the burden of NCDs among them. This study therefore assessed physical inactivity and associated factors among community dwelling adults in Umuahia South East, Nigeria.

Methods

Study design, population and sample size determination

The study was a community-based cross sectional survey with adult participants (men and women) aged 20 to 59 years recruited from communities in Umuahia North and Ikwuano Local Government Areas (LGA). Multistage probability sampling method was adopted to recruit normal residents of the selected communities. Adults who were disabled or too sick to walk and unable to communicate during the study period were excluded from the study. Sample size was estimated using the formular N/1 + N (*e*), where N represents the population size based on age distribution of the 2006 census report[20] and *e* represents level of precision (0.05) which amounted to 868, including a 10% drop-out rate.[2,19]

Data collection and measurement

Validated structured questionnaires were used to obtain information on socio-demographics. The global physical activity questionnaire (GPAQ) was used to collect data on physical activity levels (metabolic equivalent for tasks [METs] min/wk) through face-to-face interviews. Six trained research assistants were recruited and they explained study procedures and administered questionaires to the participants in the participant's preferred language (English or *Igbo*).

Socia-demographic characteristics

Socio-demographic and health information included: age, educational status, income, marital status house hold size, income, and occupation. Age was divided into two categories: ≤ 40 (reference group), and >40 years. Educational level was categorized as having no formal education (reference group) or being educated. Household size was classified as ≤3 (reference group) and >3. Income levels were divided into; <#30,000 (reference group), #30,000 to 100,000 and >#100,000. Occupation was categorized as employed (reference group) or not employed. Alcohol consumption and smoking status were also determined using Yes or No options.

Anthropometrics measurements

Anthropometric measurements were performed according to guidelines of the International Society of the Advancement of Kinanthropometry.[21] Body weight with minimal clothing was measured to the nearest 0.1kg using a calibrated digital scale and height was recorded to the nearest 0.1m using a stadiometer attached to the scale (Seca model 284, Hamburg, Germany). Body mass index (BMI) was calculated from height and weight measurements as body weight divided by square of height (weight/height (m^2) and classified as normal, overweight and obese using the WHO guidelines.[22]

Physical activity assessment

The Global Physical Activity Questionnaire (GPAQ) was used to obtain physical activity information through face-to-face interviews.[23] The questionnaire gathered information on PA performed in the previous 7 days in the following domains: work, travel-related and recreational physical activity. Physical activity level was measured using Metabolic Equivalents (METs)-minutes per week. of 8, 4 and 4, for vigorous, moderate and leisure time physical activity.[23] A dichotomous categorical variable was used to classify participants based on whether they were physically active (with MVPA ≥600 MET minutes/week) or inactive (MVPA <600 MET min/wk).[23]

Statistical analysis

Statistical analysis was performed using IBM® SPSS Statistics software, version 25. Descriptive statistics including frequency, percentage, mean, standard deviation were used to summarize socio-demographics. Univariate and Multivariate associations between physical inactivity and related factors were determined. Results were presented as in adjusted odds ratio (AOR) and 95% confidence interval (Cl), and a p-value of less than 0.05 was accepted as statistically significant.

Results

Characteristics of the participants (n=868)

Table 1 depicts the basic characteristics of the respondents. A total of 868 adults participated in the study. There was an almost equal proportion of males (49%) and females (51%). Most of the adults were married (57.5%), employed (80.3%), had more than 3 persons per household (74.5%), and earned a monthly income less than #30,000 (57.4%). Few adults reported smoking cigarettes (7.98%) and alcohol consumption (20.4%). Unemployment rate was 19.7%, most adults had completed secondary education and 60.6% had normal BMI.

Physical activity status of participants

The physical activity status is presented in Table 2. About half of the adults were physically active (50%), while 49% failed to meet the WHO recommended PA levels (inactive).

Table 1. Descriptive characteristics of the participants (n=868)

Variables	Male N (%)	Female N (%)	Total N (%)
Age			
<40 years	313 (73.6)	297 (67.0)	610 (70.3)
≥40 years	112 (26.4)	146 (33.0)	258 (29.7)
Marital status			
Single	233 (54.8)	136 (30.7)	369 (42.5)
Married	192 (45.2)	307 (69.3)	499 (57.5)
Educational status			
Not educated	44 (10.4)	72 (16.3)	116 (13.4)
Educated	381 (89.6)	371 (83.7)	752 (86.6)
Income			
<#30,000	222 (52.2)	276 (62.3)	498 (57.4)
#30,000 - #100,000	181 (42.6)	159 (35.9)	340 (39.2)
>#100,000	22 (5.2)	8 (1.8)	30 (3.5)
Household size			
1 – 3	129 (30.4)	92 (20.8)	221 (25.5)
4 – 6	296 (69.6)	351 (79.2)	647 (74.5)
Occupation			
Employed	326 (76.7)	371 (83.7)	697 (80.3)
Unemployed	99 (23.3)	72 (16.3)	171 (19.7)
Alcohol consumption			
No	321 (75.5)	370 (83.5)	691 (79.6)
Yes	104 (24.5)	73 (16.5)	177 (20.4)
Cigarette smoking			
No	377 (88.7)	422 (95.3)	799 (92.1)
Yes	48 (11.3)	21 (4.7)	69 (7.98)
Body mass index (kg/m^2)			
Normal	319 (75.1)	207 (46.7)	526 (60.6)
Overweight/obese	106 (24.9)	236 (53.3)	342 (39.4)
Physical activity			
< 600 MET-minutes/week	206 (48.5)	226 (51.0)	432 (49.8)
> 600 MET-minutes/week	219 (51.5)	217 (49.0)	436 (50.2)

MET= metabolic equivalent for task

Table 2. Physical activity status of adults stratified by sex

Variables		Physical activity status		
		Inactive	Active	P value
Sex	Male	206 (23.7%)	219 (25.2%)	0.453
	Female	226 (26.0%)	217 (25.0%)	

Physical activity assessment

Table 3 represents the results of univariate and multivariable analysis for the association between sociodemographic and lifestyle factors associated with physical inactivity. In the unadjusted model, age, educational status, household size, marital status and BMI were significantly associated with physical inactivity ($p<0.05$). After adjusting for cofounders, there was a strong association of physical inactivity with increasing age (OR=0.49, 95% CI: 0.34- 0.71), increasing BMI (OR=0.67, 95% CI: 0.49- 0.91), higher income (OR=0.65, 95% CI: 0.48- 0.89), and alcohol consumption (OR=0.67, 95% CI: 0.47- 0.97).

Table 3. Sociodemographic and lifestyle factors associated with physical inactivity

Variables	Univariate analysis OR (95% CI)	P value	Multivariate analysis AOR (95% CI)	P value
Age	2.48 (1.84-3.38)	0.000*	0.49 (0.34- 0.71)	O.000*
Sex	0.90 (0.69- 1.18)	0.453	1.32 (0.97- 1.79)	0.073
Educational status	0.57 (0.38- 0.86)	0.007*	1.25 (0.79- 1.96)	0.339
Income	1.21 (0.58- 2.54)	0.607	0.65 (0.48- 0.89)	0.006*
Household size	1.37 (1.01- 1.87)	0.043*	0.82 (0.60- 1.14)	0.239
Marital status	1.78 (1.36- 2.33)	0.000*	0.91 (0.64- 1.28)	0.574
Occupation	0.80 (0.57- 1.11)	0.178	0.98 (0.67- 1.43)	0.930
Alcohol consumption	1.54 (1.10- 2.15)	0.011*	0.67 (0.47- 0.97)	0.033*
Cigarette smoking	0.96 (0.59-1.57)	0.869	1.09 (0.64- 1.88)	0.733
Body mass index	1.60 (1.22- 2.11)	0.001*	0.67 (0.49- 0.91)	0.010*

*Significant at $p<0.05$, AOR=Adjusted Odds Ratio

physical inactivity levels for countries like Germany (21.1%), Netherlands (22.5%) and Estonia (23.7%).[26] These results negate the notion that the prevalence of physical inactivity is a function of a country's income and is usually high in developed countries and low in less developed and underdeveloped countries.[27] The high prevalence of physical inactivity observed in our study could be attributed to occupations been more sedentary and use of motorised transportation. For instance, our study participants were mostly employed in white collar jobs, which may in turn have reduced their activity levels, since occupational activity is included as a component of daily PA in adulthood as recorded in the GPAQ.[28]

Discussion

In this study, physical inactivity was high among study participants with age, BMI, income and alcohol consumption as associated factors. In addition, a third of the participants was overweight and/or obese.

Consistent with other studies, high prevalence of physical inactivity has been reported among adults in other settings.[11,12] In congruent with our study, a high prevalence of physical inactivity was reported for some high income countries including China (63.1%), Portugal (63.7), Cyprus (44.4%), Singapore (36.5%), Italy (55.6%), Kuwait (67%), Malta (62.8%), Brazil (47%), and Poland (46.1).[24,25,26] On the contrary, studies have reported low

Additionally, urbanization which is associated with sedentary lifestyle and increased weight gain among adults in urban population could also be responsible for the high levels of physical inactivity as observed by Renato Campos Freire.[14] Physical inactivity in this study was higher than reported in studies conducted in Kenya (14.4%), Burkina Faso (7.8%), Malawi (8.4%), Ghana (8.8%), Mexico (19.4%) and Nigeria (32.4%)[16] probably due to differences in lifestyles, study period, setting and methodology.

Age is one of the significant factors associated with physical inactivity in this study as agreed by other authors.[11,29,30,31,43] In this study, we found that middle aged adults had lower odds of been physically inactive compared to younger adults. It is

possible that middle aged adults make conscious efforts to exercise for health benefits since they are at a higher risk of having NCDs.[32] Again, the occupational activities of middle aged adults may be another possible reason. Consistent with our findings, physical activity level was reported to be higher among middle aged/ older adults in both sexes.[11,30] On the contrary, some studies did not find significant associations between physical inactivity and age.[29]

High BMI, which is a known risk factor for NCDs was an important determinant of physical inactivity in this study.[33] The current study revealed that adults with high BMI (overweight or obese) had lower odds of been physically inactive. Consistent with our findings, a study noted that some individuals with obesity engaged in leisure-time physical activity, for more than four hours weekly, reinforcing the importance of knowing the challenges faced by overweight or obese adults so as to plan interventions that target them.[34,35,44] The observed association could also be a reflection of weight management, physical improvement and the release of endorphins, dopamine and adrenaline.[36]

Income is another key determinant of physical inactivity in the present study. Adults in the income category #30,000 - #100,000 had lower odds of been physically inactive compared to those who earn less (< #100,000). A possible explanation for this finding may be attributed to more engagement of middle aged adults in recreational activities which is common among adults in higher income levels.[12] It is also possible that middle aged adults may have additional resources to access and utilize leisure time physical activity opportunities.[37] The finding is however at variance with another study from Ethiopia where adults with high income were more likely to be inactive than those with low income.[38]

Furthermore, the current study also highlights the association between physical inactivity and alcohol consumption. Evidence from studies showed a positive relationship between physical activity and alcohol consumption.[39,40] Choi et al.[40] found that moderate alcohol consumers had higher physical activity levels when compared to non-alcohol consumers. A study by Werneck et al.[41] indicated that daily alcohol consumption is related to higher physical activity among older adults and young women, but with lower physical activity among young and middle-age male adults. Another study, found a dose-response relationship between alcohol consumption and physical activity, indicating that, as drinking increased, physical activity also increases.[42] A plausible explanation could be attributed to the hyperactive nature of alcohol drinkers and socialisation. On the other hand, a study reported that people who smoked cigarettes or drank alcohol were more likely to report physical inactivity than people who do not smoke or drink alcohol.[15] The same study explored gender difference and found that smoking cigarettes and drinking alcohol were significantly associated with physical inactivity level in men but not in women. The reason was attributed to the fact that the proportion of women who smoked cigarettes and drank alcohol was relatively lower than men in their study.[15]

This study has some strengths and limitations. Information on physical activity was self-reported using the GPAQ, and this may have underestimated or overestimated the actual PA of the adults. However, the GPAQ has been validated and recommended for use by the WHO for assessing PA in adults.This study is limited by the cross-sectional nature which does not allow for establishing causal associations, however, the purpose of the study was to investigate associations rather than causality. Also, the sample was drawn from only one geopolitical region out of six in the country, therefore, limiting the generalizability of the findings to other geographical zones. Despite these limitation, our findings serve as a basis for future studies on physical inactivity and associated factors among community dwelling adults in other geopolitical regions of the country.

Conclusion

Physical inactivity was high among the study participants. Age, income, BMI and alcohol consumption were major factors associated with physical inactivity. The findings underscore the need to intensify efforts at promoting and strengthening effective physical activity interventions among community dwelling adults to reduce NCDs

Author's contribution

UPO and UAU conceptualised, designed and read the final draft. UPO, UAU and OBF developed the methodology for coding and statistical analysis. OBF and UPC were involved in structuring and validation of the research questions, data collection and wrote the first draft pf the manuscript. All authors approved the final manuscript and can take public responsibility for its content.

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Ethical approval

The Health Research Ethics Committee (HREC) of the Federal Medical Centre, Umuahia (project number: FMC/QEH/G.596/Vol.10/447 and FMC/QEH/G.596/Vol.10/448) granted ethical approval for the study. All participants read and gave informed consent prior to the interview.

Conflict of Interest

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