REVIEW ARTICLE   **Open Access**

Potential of Peptide-Based Non-Structural Protein 1 (NS1) Inhibitor in Obstructing Dengue Virus (DENV) Replication

Muhammad Mikail Athif Zhafir Asyura[1]*, Ahmad Fauzi[2], Fakhru Adlan Ayub[3]

[1] Faculty of Medicine, University of Indonesia, Jl. Salemba Raya No.4, Jakarta, Indonesia
[2] Faculty of Medicine, University of Indonesia, Jl. Salemba Raya No.4, Jakarta, Indonesia
[3] Faculty of Medicine, University of Indonesia, Jl. Salemba Raya No.4, Jakarta, Indonesia
*Corresponding Author. E-mail: muhammad.mikail91@ui.ac.id Telp: +62-8118884480

ABSTRACT

Introduction: Dengue Virus (DENV) is the pathogen for human dengue fever and is responsible for 390 million infections per year. The viral genome produces about 10 viral protein products, one of them being NS1. The NS1 protein plays a key role in viral replication and stimulation of humoral immune cells, thus being the perfect candidate to create an effective antiviral drug or vaccine for dengue

Methods: Dengue Virus (DENV) is the pathogen for human dengue fever and is responsible for 390 million infections per year. The viral genome produces about 10 viral protein products, one of them being NS1. The NS1 protein plays a key role in viral replication and stimulation of humoral immune cells, thus being the perfect candidate to create an effective antiviral drug or vaccine for dengue

Conclusion: The review established promising results of using peptide-based intervention on NS1. Further *in vivo* and randomized controlled trials are advised to solidify the applicability and biosafety of the intervention

Keywords: antiviral agents; dengue; peptides; proteins

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Introduction

Dengue Virus (DENV) is a single stranded RNA flavivirus and a major causative agent of dengue fever, West Nile, and yellow fever.[1] DENV is transmitted via mosquito (*aedes aegypti* and *aedes albopictus*) saliva to humans. Throughout history, DENV is responsible for 390 million infections per year with 96 million among them showing clinical symptoms and 2.5% mortality rate each year. [2] DENV infections are more common in tropical countries as in Indonesia, the prevalence of DENV infections are 77.96 cases per 100,000 person-years in 2016. [2]

Dengue was a global health issue that endemic in around 100 countries, mostly tropical and subtropical. Over the last decade, Dengue issues have increased quickly. WHO states that dengue infects about 390 million and causes up to 100 million cases every year. WHO proposed a new dengue classification based on the severity because of changes in epidemiology and incidence rates. [2] Indonesia is one of endemic countries and the epidemiology of dengue fever often shows as a case series. Indonesia has the second largest dengue fever cases among 30 other endemic countries and the most prevalent in Java, particularly West, Central, and East Java.[1,2]

DENV has 4 different serotypes: DENV-1, DENV-2, DENV-3, and DENV-4. [3] The DENV RNA strain contains 10 viral protein products that can be classified into 3 structural proteins and 7 non-structural proteins. The 3 structural protein classes are Envelope (E), Capsid (C), and pre-Membrane (prM).[1-5] The other 7 non-structural (NS) proteins are NS1, NS2A, NS2B, NS3, NS4A, NS4B, and NS5.[6-10] NS1 is a major protein in DENV viral replication[5,9] NS1 is sequenced by 352 amino acid residue and has 70% similarity to other DENV serotype.[5] Other roles of NS1 include stimulating immune cell to release vasoactive cytokines which lead to vascular leakage.[1,10] NS1 protein has 3 important domains: the hydrophobic β-roll as a domain for dimerization process (located on 1-29 residue), the wing as a connector subdomain (located on residue number 30–37 and 152–180, the α/β subdomain and residues number 38–151), and β-ladder (residue number 181–352) visible in **Figure 1**. Which play a vital role in NS1 physiology. [1, 10] This type of protein has been considered as a potential vaccine of dengue due to its pathological roles. NS1 can be soluble in host plasma and bind to prothrombin, then alter its function. Also, NS1 can bind to TLR4, TLR2, and TLR6 Receptor which induce proinflammatory cytokines release, leading to vascular leakage. The anti-NS1 vaccines act as an antagonist of this NS1 protein to inhibit its pathological roles. Also, anti-NS1 can induce antibodies and complement-dependent mechanism to lysis the DENV-infected cells. [6-8]

Many researches have been conducted to search for DENV vaccines or drugs. [11-16] Nevertheless, there are still no effective and specific vaccines or drugs to treat DENV infection, implied by the ever-increasing prevalence of DENV worldwide and also in Indonesia. [2,11,13-16]. On the other hand, data shows that dengue fever prevalence is very high and keeps rising especially in Asia. [2] Treatment for dengue fever and severe

dengue fever are focused on maintaining and controlling patient body fluid. [2,17] Therefore, to control and prevent DENV infection more effectively, research for DENV vaccines or drugs is still one of major focus.

Understanding which type of vaccines and the mechanism of action remained a big hurdle for scientists. In this literature review, we focused on reviewing the action mechanism of NS1 and DENV outcome if the NS1 protein is inhibited. Despite much research, there is still no exact mechanism of NS1 in viral replication. Although a study suggests that NS1 plays a role in formation and stabilization of viral membrane organelles. [2,6-8] By understanding these NS1 mechanisms, scientists have found some potential candidates for vaccines. Therefore, these vaccines still need to be investigated to improve it is efficacy and safety. [9] Hence, by considering the minimal and slow process in DENV vaccine development, peptide-based inhibition of NS1 protein could play a major role in decreasing DENV numbers significantly. Thus, we conducted this literature review based on that purpose in mind and to contribute towards the World Health Organization's sustainable development goals (SDG) number 3, which is good health and wellbeing. Especially two of its targets to reduce mortality of communicable disease and cure all preventable causes of deaths in under 5 years old children as in Indonesia itself, 18.01% dengue cases had been reported with death proportion of 38.89% among all ages per December 2020.[15]
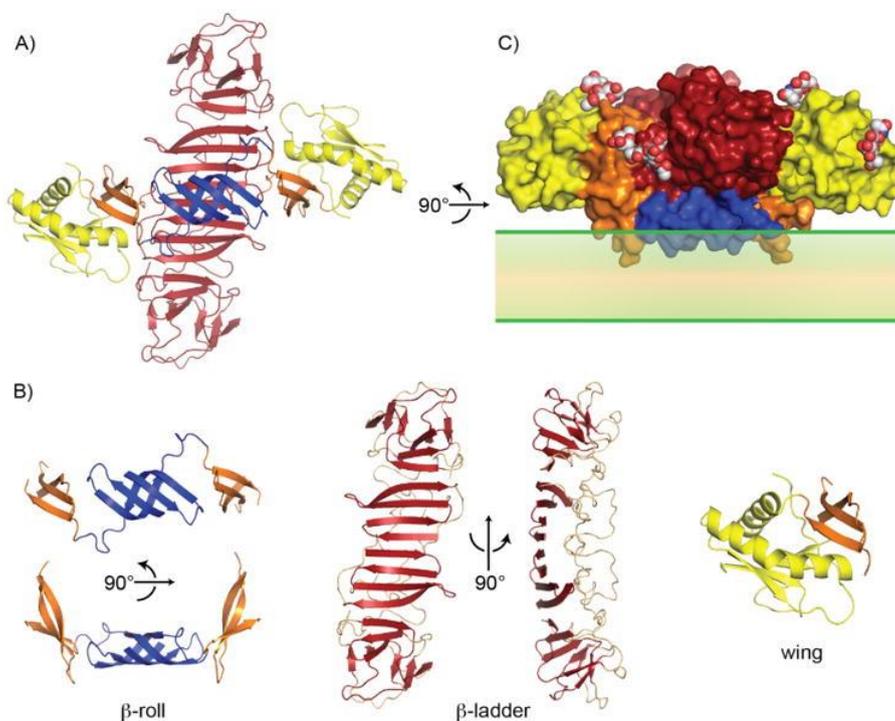

Figure 1. NS-1 Protein Structure [9]

Content

Search Strategy

This literature review was assembled by searching, compiling, and analyzing various studies that

investigated the role of non-structural protein 1 (NS1) in viral replication and the potential use of peptide-based treatment that inhibits the protein. Search terms used included ("Peptide" OR "Peptide drug") AND ("Nonstructural protein 1" OR "NS1") AND ("Dengue") AND ("Inhibit" OR "Reduce"). The sources were cited from Pubmed/Medline, Science Direct, Proquest, Wiley Online Library, Directory of Open Access Journal (DOAJ), and Cochrane library. From the databases, 11 studies were included in this review in which 9 assessed the potential of NS1 as a target and 2 studies assessed the potential usage of peptide-based interventions to inhibit DENV replication. Variables mentioned and analyzed from the 9 included studies for NS1 targeting includes the mechanism and the advantages if compared to the current and other alternative interventions. Furthermore, analysis of the 2 included studies for DENV inhibition will focus on the efficacy of the said treatment on *in vitro* and *in vivo* situations. Additional materials collected via individual searching from the said databases was also conducted when necessary, to supplement this review

Figure 2. Provides a visual representation of the literature search strategy
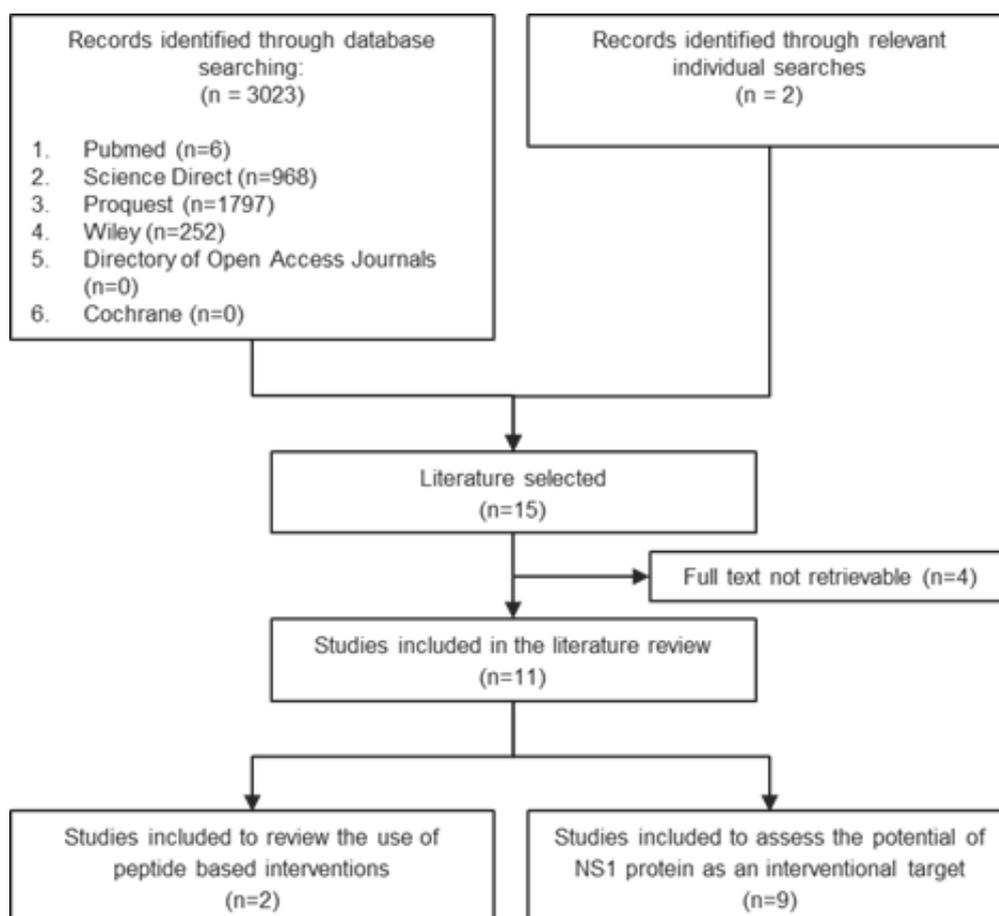

Figure 2. Flowchart of the Literature Search Strategy

Current State of Dengue

The graph below **(Figure 3)** shows the Incidence Rate of Dengue per 100.000 populations in Indonesia by Province in 2016. From the graph, we can conclude Bali has the highest Incidence Rate and the lowest is

Papua. The first case of dengue fever was in Jakarta, 1968. Since then, the Incidence Rate (IR) of dengue fever shows an increasing trend. It increased from 0.05 - 35-40 per 100.000 population in 2013. Dengue fever has infected all of 34 provinces and 80% of 497 cities in 2017. The spreading in the cities of Indonesia can be looked at from the incidence rate per 100.000 population in the cities from each year, and it shows positive trends. These are summarized on graph in **Figure 4** that shows positive trends of incidence rate per 100.000 population from 1986-2016.[15]
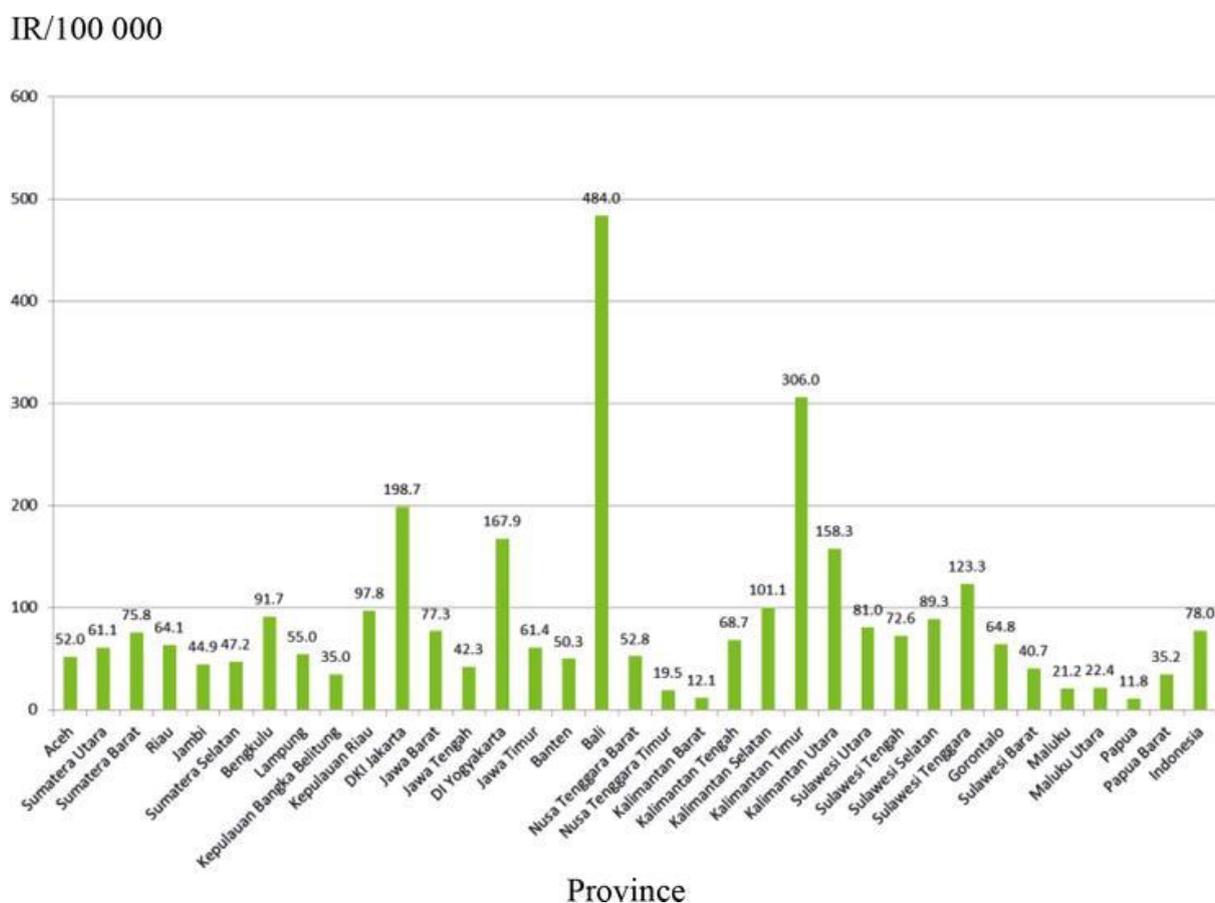

Figure 3. Incidence Rate of Dengue in Indonesia by Province [15]

Vaccine for dengue is still an issue to this day because there is no effective or commercial vaccine.[10] The first dengue vaccine introduced is Dengvaxia developed by Sanofi Pasteur. The vaccine licensed in December 2015 in Mexico for individuals between 9-45 years of age.[6-8] Many approaches have been used, such as live attenuated, DNA Vaccine, subunit antigen, and other approaches, and several groups show good progress and efforts in vaccine development. Currently, the strategy has each status and phase, as shown in the table below.[15]
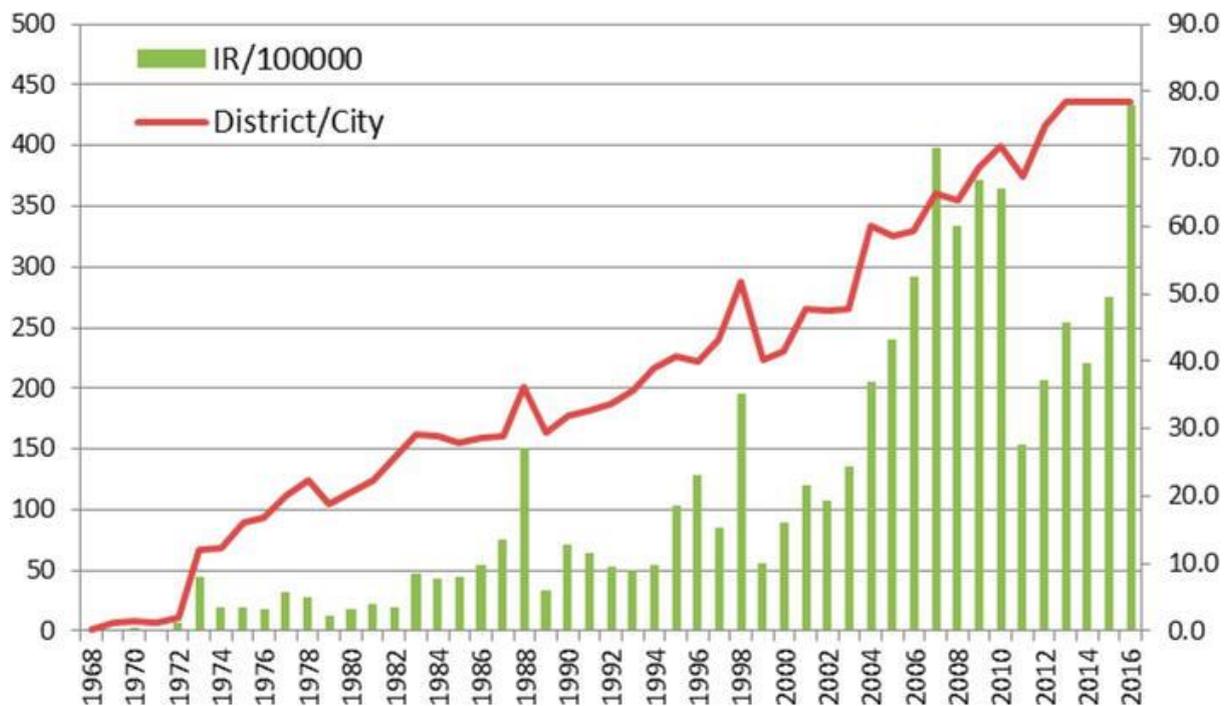
Figure 4. Incidence Rate of Dengue in Indonesia and Number of Cities Infected [15]

The Importance of Non-Structural Protein 1 (NS1)

As mentioned before, no such anti-dengue drug or vaccine has been successfully synthesized and was proven effective against the viral strain despite its increasing need and urgency. Connected to that concern, increasing focus is needed to be put on modalities other than supportive care. Antiviral approaches have been shown to target structural and non-structural proteins of DENV due to their pivotal role in viral replication and transmission. Multiple candidate proteins have been identified with NS proteins being the majority, especially the NS1 protein.[18-23] The DENV NS1 protein is a glycoprotein translated by the viral genome in different structural forms **(Figure 1.)** depending on its location. The NS1 protein is expressed in the form of a monomer but transforms into a membrane-bound dimer on the cell surface of the host cell. Moreover, the protein is secreted in the form of a hexamer (open barrel structure with three dimers forming a hydrophobic region) that cycles in the patient's circulatory system.[21,23] Functionality wise, the protein plays an essential role in viral replication but the exact mechanism is still unknown. Study conducted by Plaszczyca et al managed to clarify this question by demonstrating different domains of the protein being required for the synthesis of membrane organelles of DENV.[3,24] This output provides useful information in designing and determining peptide interventions with the property to bind on these domains to inhibit viral replication as a whole. Thus, via binding of those domains, the synthesis of DENV essential proteins is inhibited hence disrupting the required ecosystem for the virus to replicate effectively. Moreover, akin to the mechanism of an enzyme, the individualized peptide made for this intervention is not easily degradable thus enabling it to be used multiple times in succession.[3,24]

Akey et al. further expanded on this idea by identifying different potential binding domains in the various structural forms of the protein, especially in its dimer form.[8] In **Figure 1**, the NS1 protein is presented in its dimer form with its three binding domains: the hydrophobic β-roll (blue), the wing that consists of α/β subdomain (yellow), and the β-ladder domain (red). Despite the β-ladder having minimal structural functionality, the hydrophobic β-roll plays an important role in the dimerization process of the protein while the wing domain is responsible to connect all the domains together into an integral structure.[18,6-8] Hence, in theory, there is a possibility to design certain peptides that are complementary to these domains with the purpose in intercepting their physiology.[1] Similar methods have been implemented by Huang et al. in which peptide-based antimicrobial agents are used on non-structural proteins. In this study, three major pathways were tested: the inhibition of viral entry, immunomodulation of the viral strain, and the interception of detailed steps on the viral replication cycle, with the latter being the most effective in reducing viral titre in the infected cell.[20] The strategies were implemented on nonstructural proteins that plays a role in viral replication such as NS2B/NS3 (protease), NS5 (RNA-dependent RNA polymerase, RdRp), and NS3 (helicase) being the prime targets. [13,2]

Although NS1 proteins have yet to be targeted due to its enigmatic role in viral replication, there are a few properties of the protein that alleviate its status as a therapeutic agent compared to current interventions. Firstly, one of the biggest hurdles of vaccine development against dengue is due to the many serotypes of DENV. This translates to multiple vaccines needing to be tailored for each serotype and thus slowing the overall development. This is tackled by the housekeeping nature of NS1 protein, meaning that it exists in every serotype of DENV. Thus, treatment made against NS1 in theory would be effective regarding the DENV serotype. Secondly, previous peptide-based treatment targets structural proteins of DENV such as the envelope protein. These interventions named "neutralizing antibodies' 'block the attachment and entry of the virus into host cells. Albeit it being successful in doing so, they impose the risk of antibody dependent enhancement (ADE) in which viral infection is induced by antibody production of the host cell. This concern is tackled by the non-structural nature of NS1. Instead, antibodies made against NS1 or anti-NS1 showed a therapeutic effect in some studies, reducing viral replication by complementary binding to complement-dependent cytotoxicity (CDC) of infected cells. [22-25] Hence in short, the NS1 protein is a potent target for intervention due to it being highly conserved among genomes of different DENV serotypes thus one individualized peptide, in theory, should be effective in inhibiting viral replication albeit the DENV serotype. And secondly, peptide-based intervention would not elicit ADE thus increasing its applicability biosafety wise.

Peptide-Based Interventions on Viral Proteins of DENV

Antiviral peptides of DENV infection development focus on blocking virus entry of viral structural

proteins function and enzymes. Furthermore, it blocks viral RNA processing host cells.[3] Peptides drugs roles as inhibitors of viral replication, with the main targets being host cell receptors or attachment factors, viral structural proteins, and viral non-structural proteins. The drugs will prevent the attachment and binding of the viral proteins and subsequent entry of DENV. Furthermore, it will inhibit viral fusion and viral entry by targeting viral structural proteins. Modified peptide drugs that direct non-structural proteins will restrain the viral replication cycle.[13]

Antiviral peptides have several limitations. The major problems are the peptide's instability and bioavailability. In vivo activities shown as unmodified peptides in human serum degrade in a short time. There are numerous chemical modifications for increasing the peptides' stability and bioavailability by controlling the physicochemical parts of peptides. There are various ways to enhance the peptides' antiviral, such as identifying vital amino acids for inhibition by mutagenesis assays and cell-penetrating peptides and increasing cell permeability. To settle the oral bioavailability, it uses peptide sequence associated with cell-penetrating peptides (CPP) to deliver antiviral peptides for inhibitory activity by crossing the permeability barrier into the cell. Galactoside conjugated by tar protein can deliver the fusion protein to all the tissues in mice without restrained.[13]

Efficacy Analysis of Peptide-Based NS1 Inhibitor from Current Studies

Limited studies were available that directly analyzed the efficacy of peptide-based drugs on NS1 protein due to the only recent clarification of its function within the viral replication cycle. Despite that, there are two studies conducted by Songprakhon et al and Chen et al that analyzed the protein via *in vivo* and *in vitro* respectively. In Songprakhon et al, 11 potential peptides were identified using biopanning assays which were then further screened *in silico* using molecular docking to yield 4 sequences. These 4 sequences were then transferred into Huh7 cells that were infected by DENV-2 and viral production was then taken as a comparator to establish the protein's potential. Results were shown in **Figure 5.** With all potential peptides showing significant reduction in viral production in comparison with the untreated control. Furthermore, increasing the administration dose from 10 µM to 20 µM improves the reduction of viral production, concluding a dose-dependent relation between inhibition of viral production and NS1 peptide concentration.[20]. From Chen et al., different *in vivo* studies of peptide-based intervention for the inhibition of NS1 protein were evaluated. Most studies yielded positive results with the outcome being improved survivability of the infected mice with DENV. Moreover, the peptide-based intervention also prevented hemorrhage due to severe DENV and reduced viremia within the mice.[20]
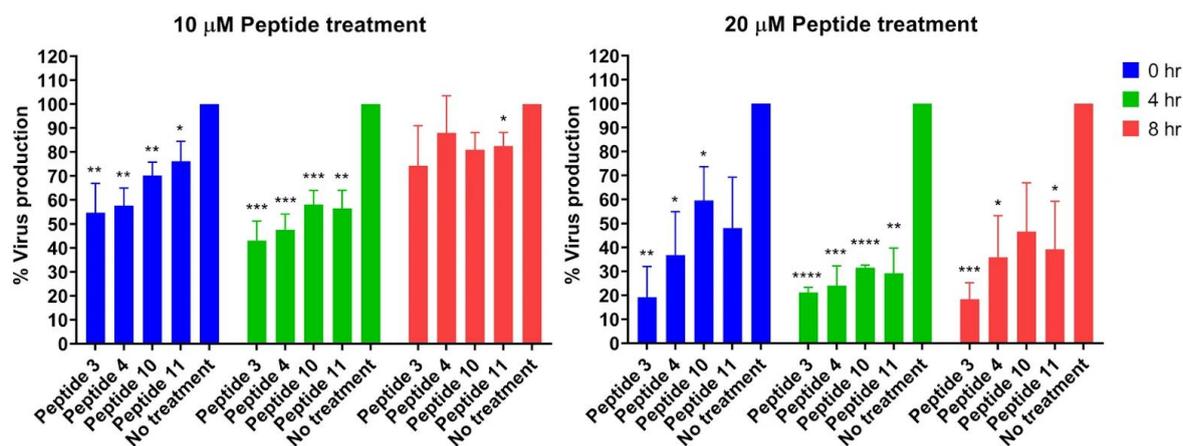
Figure 5. Viral Production Values after Peptide Intervention [20]

Biosafety of Peptide-based Intervention

Castanospermine, a natural alkaloid derived from *Castanospermum Australae* tree, has an ability to inhibit α-glucosidase I and II. These enzymes were important in N-glycosylated glycoprotein folding mechanism.[24] Celgosivir, a prodrug from castanospermine has been tested in phase 1 and 2 clinical trials in some HIV and HCV patients. However, there is no significant result in HIV and HCV cases yet having no significant side effects.[25] Study regarding the celgosivir effect on another flavivirus, the DENV, has been tested by Low JG, *et al* in 2014. The results in this double-blinded randomised clinical trial were similar in HCV and HIV studies. Nevertheless, there are some mild-to-moderate diarrheas but no other severe effects reported in this study which mean Celgosivir is barely safe to use.[25]

Strength and Limitations

The strength of this literature review lies on the positively significant result of peptide-based interventions as a potential inhibitor of NS1 proteins. The values shown by Songprakhon et al were significantly impressive in comparison to the control culture.[20] *In vivo* wise, the study conducted by Chen et al showed nearly all types of peptide approaches reaching a 100% survivability rate.[23] Moreover, data from **Table 1.** shows the current vaccine update for DENV with most still being in phase 1.[23] Hence, the urgency for an alternative treatment for DENV persists until a fully developed vaccine is publicly announced.[27] However, due to the only recent understanding of the essentiality of NS1 protein, limited studies were available that could be included within this discussion. Furthermore, despite the identification of the essential role of NS1 protein, efficacy was only analysed via *in vitro* and *in vivo*. Hece, further clinical trials should be initiated to establish the efficacy and the effectiveness of peptide-based interventions on human subjects and control.

Table 1. Current Vaccines for Dengue Status [23]

No	Strategy	Developer	Current status
1	Live attenuated yellow fever 17D/DENV chimeric vaccine	Sanofi-Pasteur	Phase 3 trials with tetravalent formulation in DENV endemic countries
2	PDK cell-passaged live attenuated vaccine	WRAIR/GSk	Phase 2 trials with a tetravalent formulation in endemic countries
3	Live attenuated DENV Delta-30 mutation and intertypic DENV chimeric vaccines	NIH/Johns Hopkins	Phase ½ trials with monovalent formulations completed; tetravalent
4	Dengue prM-E DNA vaccine	NMRC	Phase 1 initiated
5	Recombinant 80% subunit antigen vaccine	Hawaii Biotech/Merck	Phase 1 with monovalent vaccine initiated
6	Purified inactivated vaccine	Wrair	Phase 1 with monovalent vaccine initiated
7	Live attenuated chimeric DENV vaccine	CDC	Phase 1 with monovalent vaccine initiated

Abbreviations: PDK, primary dog kidney cells, WRAIR, Walter Reed Army Institute of Research; GSK, GlaxoSmithKline Biologicals; NIH. National Institute of Health; prM-E, pre-membrane-envelope; NMRC, Naval Medical Research Center; CDC, Centers of Disease Control and Prevention

Conclusion

In conclusion, DENV has been a lingering problem globally especially in developing and tropical countries. Despite having much focus being put on the disease beforehand, the possibility of developing a vaccine has been futile due to the many serotypes of the virus. With the functional discovery of the NS1 protein, arose the possibility to implement peptide-based intervention that targets the protein. The protein plays a major role in the viral replication cycle, hence by inhibiting its role, transmission of the virus could be prohibited. *In vitro* and *in vivo* studies of the interventions yielded positive results in decreasing the viral concentration and improving the survivability rate of the subjects. Although, further *in vivo* trials and randomized controlled trials are recommended to ensure the optimal dose, administration method, and efficacy of the peptide intervention. Moreover, proper cost-effectiveness analysis should be conducted on the mass production of the peptide and a concrete plan of the public health intervention if deemed suited for an Indonesian context. Hopefully, the implementation of this novel intervention could reduce the burden of DENV as a neglected tropical disease thus contributing to the World Health Organization road map and sustainable development goals (SDG) number 3, which is to ensure good health and wellbeing especially in eradicating all infectious diseases by the year 2030.

Conflict of Interest

The authors declare no competing interests.

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ORIGINAL ARTICLE   **Open Access**

The Relationship of Anemia in Pregnant Women with Anthropometry and Apgar Score for Newborns in Dr. Tadjuddin Chalid Hospital, Makassar

Sri Rahayu[1]*, Azizah Nurdin[2], Rosdianah Rahim[3]

[1]Medicine Education Study Program, Faculty of Medicine and Health Sciences, Alauddin State Islamic University, Makassar, Indonesia

[2]Department of Biomedic, Faculty of Medicine and Health Sciences, Alauddin State Islamic University, Makassar, Indonesia

[3]Department of Anatomy, Faculty of Medicine and Health Sciences, Alauddin State Islamic University, Makassar, Indonesia

*Corresponding Author. E-mail: rhy27698@gmail.com Mobile number: +628 242 412 945

ABSTRACT

Introduction: Anemia is one of the problems in pregnant women that can affect the anthropometry of newborns that containing weight, body length, head circumference, and newborn score. The aim of this study aimed to determine the relationship between anemia of pregnant women to anthropometry and the Apgar score of newborns at Dr. Tadjuddin Chalid Hospital Makassar.

Methods: The method used in this research is observational analytic with a cross-sectional design. Sampling was done by purposive sampling. The total sample of 269 deliveries at Dr. Tadjuddin Chalid Hospital Makassar. The research data were sourced from secondary data such as patient identity, anemia of pregnant women, and infant anthropometry including weight, length, head circumference, and apgar score measured immediately after birth.

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Results: The results of this study indicate that anemia of pregnant women is significantly related to newborn body weight (p = 0.007), newborn body length (p = 0.011), newborn head circumference (p = 0.039), and anemia of pregnant women do not have a significant relationship with the Apgar of newborns score (p = 0.088).

Conclusion: This study concluded that the anemia status of pregnant women has a relationship with anthropometry of newborns on the parameters of body weight, body length, head circumference of newborns, and anemia status of pregnant women has no relationship with the Apgar score of newborns.

Keywords: Anemia of pregnant women; anthropometry; apgar score

Introduction

Anemia is defined as a decrease in the number of red cell mass which results in failure of the function of erythrocytes to carry sufficient oxygen to peripheral tissues (decreased oxygen carrying capacity).[1] According to the World Health Organization (WHO), mothers with anemia can be concluded when the Hemoglobin (HB) level in the blood is < 11 gr/dl, whereas based on sources from the Indonesian Ministry of Health, anemia in pregnant women is a condition of mothers with anemia of < 11 gr/dl in the first and third trimesters and of < 10.5 gr/dl in the second trimester of pregnancy.[2]

According to the World Health Organization (WHO), an estimated 1.62 billion people in the world suffer from anemia, and 56.4 million of which are pregnant women. WHO estimates that around 18.1 million pregnant women in Southeast Asia have anemia. Where the Southeast Asia has the highest prevalence compared to other countries.[3]

Data obtained from the Health Office of South Sulawesi Province, from 23,839 pregnant women whose hemoglobin levels were checked, pregnant women with hemoglobin levels of 8-11 mg/dl were 23,478 people (98.49%) while pregnant women with hemoglobin levels of < 8 mg/dl were 361 people (1.15%).[4] Data from Dr. Tadjuddin Chalid Hospital in Makassar City in 2017 showed that as many as 731 vaginal deliveries were still dominated by the incidence of anemia in pregnancy, namely around 19 patients each month who were known during ANC and during delivery, and Dr. Tadjuddin Chalid Hospital usually accepts referral patients from local health centers.

There are three causes of direct maternal death, namely bleeding by 32%, hypertension by 25%, and infection by 5%. One of the indirect causes of death in pregnant women is anemia. Anemia contributes to the risk of death in pregnant women during pregnancy and after delivery by looking at other risk factors.[5]

Identification of the efforts to succeed in maternal health can be viewed from the Maternal Mortality

Rate (MMR) indicator. Where, MMR is the number of maternal deaths during pregnancy, childbirth and the *puerperium* during or in terms of its management but not due to other causes, for example accidents, etc., in every 100,000 live births. According to the Indonesian Ministry of Health in 2014, the MMR in Indonesia alone amounted to 359 per 100,000 live births. Where, if viewed from the Millennium Development Goals (MDG's) target in 2015 of 102 per 100,000 live births, this figure is still far from the estimated target.[6]

In Makassar, MMR was recorded for 3 consecutive years, namely 2015 (5 out of 25,181), 2014 (5 out of 24,590) and 2013 (4 out of 24,576). The cause of MMR in Makassar is due to bleeding other than hypertension and infection. Where anemia during pregnancy contributes to a sizeable death rate due to bleeding.[7]

Pregnant women who have anemia will have the risk of morbidity and mortality, especially in the increased anemia in pregnancy which causes high MMR when it occurs in Hemorrhage post-partum, and will have an impact on the fetus such as the risk of pre-term birth, birth weight, and *Apgar* value will also be low.[8]

Anemia will have an impact on pregnant women and the fetus where they can experience abortion, fetal obstruction during pregnancy, low birth weight (LBW), premature rupture of membranes (PROM), rapid cord decompensation infection (HB<6 g%), hyperemesis gravidarum, premature, hydatidiform mole, antepartum hemorrhage, intrauterine death, congenital defects and perinatal death.[9]

High incidence of anemia and the large impact of anemia on newborns made the researchers raise this topic as the research material.

Methods

The method used in this research was quantitative research using observational analytic methods with cross sectional approach. Design of this study was used to determine the relationship of the dependent variable, namely the anthropometry of newborns including body weight, body length and head circumference, with the independent variable being anemia in pregnant women. Research was conducted in December 2019 - January 2020 at Dr.Tadjuddin Chalid Hospital, Makassar City and has received ethical eligibility with the number E.003 / KEPK / FKIK / XII / 2019 dated 5 December 2019. Population in this study was all pregnant women who gave birth at Dr.Tadjuddin Chalid Hospital, Makassar City. Sampling was conducted using non-probability sampling techniques, namely purposive sampling with a total sample of 269 which met the inclusion and exclusion criteria. Those included in the inclusion criteria were pregnant women who gave birth to Dr. Tadjuddin Chalid Makassar City from January to December 2018, the method of vaginal delivery, has medical record data that can be evaluated, including: patient identity in the form of names and hemoglobin levels of pregnant women, anthropometry of newborns, namely body weight, body

length and head circumference and the A*pgar* score of the newborn. While the exclusion criteria were mothers with multiple pregnancies (Gemelli), suffering from diabetes, hypertension, heart disease, and asthma, and a history of labor: premature rupture of membranes, prolonged labor, IUGR / stunted fetal growth. Data source used in this research was secondary data. Secondary data were obtained from medical records at Dr.Tadjuddin Chalid Hospital Makassar City. The data obtained were analyzed using IBM SPSS 23 software. Analysis of the relationship between the dependent and independent variables was conducted using the Chi-Square test.

Result

Table 1 Distribution of Respondents Based on Medical Record Data Dr. Tadjuddin Chalid Makassar City in 2018

Characteristics	n	%
Anemia		
Yes	105	39
No	164	61
body weight		
< 2,500 grams	26	9.7
2,500 – 4,000 grams	240	89.2
> 4,000 grams	3	1.1
body length		
<48 cm	80	29.7
48-52 cm	189	70.3
head circumference		
<32 cm	27	10
32-37 cm	242	90
baby's Apgar Score		
high	5	1.9
moderate	8	3.0
normal	256	95.2

Source: Secondary Data, 2018

Table 1 shows the number of pregnant women who gave birth at Dr. Tadjuddin Chalid Makassar City in 2018 with anemia of 105 people (39%) while those who did not experience anemia were 164 people (61%). Data for babies with low birth weight (< 2,500 grams) were 26 (9.7%), babies with macrosomic birth weight (> 4,000 grams) were 3 babies (1.1%), while babies with normal birth weight (2,500 – 4,000 grams) of 240

people (89.2%). Data on babies with normal body length (48 - 52 cm) were 189 babies (70.3%), while babies with body length of < 48 cm were 80 babies (29.7%). Data on babies with normal head circumference (32 - 37 cm) were 242 babies (90%), while babies with head circumference < 32 cm were 27 babies (10%). Data for babies with high *Apgar* score (0-3) were 5 babies (1.9%) while babies with moderate *Apgar* score (4-6) were 8 babies (3.0%) and babies with normal A*pgar* score (7- 10) were 256 babies (95.2%).

Table 2 Analysis of the Relationship between Anemia in Pregnant Women and Baby's Body Weight on birth at Dr. Tadjuddin Chalid Makassar City in 2018

Anemia on Pregnant women	baby's body weight on birth (gram)		Total	*p-value*
	< 2,500	≥ 2,500		
Yes	17 (65.38 %)	88 (36.21%)	105 (39.03 %)	0.007*
No	9 (34.62 %)	155 (63.79%)	164 (60.97%)	
Total	26 (9.67%)	243 (90.33%)	269 (100.00%)	

Source: Secondary Data, 2018

*Chi Square test, p value <0.05

Table 3 Analysis of the Relationship between Anemia in Pregnant Women and the Length of the Birth of a Baby at Dr. Tadjuddin Chalid Makassar City in 2018

Anemia on Pregnant women	baby's body length on birth (cm)		Total	*p-value*
	< 48	48 – 52		
Yes	41 (39.05%)	64 (60.95%)	105 (39,03%)	0.011*
No	39 (23.78%)	125 (76.22%)	164 (60.97%)	
Total	80 (29.74%)	189 (70.26%)	269 (100.00%)	

Source: Secondary Data, 2018

*Chi Square test, p value <0.05

Table 4 Analysis of the Relationship between Anemia in Pregnant Women and the Head Circumference of a Born Baby at Dr. Tadjuddin Chalid Makassar City in 2018

Anemia on Pregnant women	Baby's head circumference on birth (cm)		Total	*p-value*
	< 32	32 – 37		
Yes	16 (15.24%)	89 (84.76%)	105 (39.03%)	0.039*
No	11 (6.71%)	153 (93.29%)	164 (60.97%)	
Total	27 (10.04%)	242 (89.96%)	269 (100.00%)	

Source: Secondary Data, 2018

Chi Square test, *p* value <0.05

Table 5 Analysis of the Relationship between Anemia in Pregnant Women and the *Apgar* score of Baby Birth in Dr. Tadjuddin Chalid Makassar City in 2018

Anemia on Pregnant women	*Apgar Score* on birth		Total	*p-value*
	Asphyxia	Normal		
Yes	9 (8.57%)	96 (91.43%)	105 (39.03%)	0.088*
No	5 (3.05%)	159 (96.95%)	164 (60.97%)	
Total	14 (5.20%)	255 (94.80%)	269 (100.00%)	

Source: Secondary Data, 2018

Chi Square test, *p* value <0.05

Discussion

Table 2 shows that pregnant women who gave birth at Dr. Hospital Tadjuddin Chalid Makassar City in 2018 experienced anemia as many as 105 people, of which 17 people (16.9%) gave birth to babies with low birth weight < 2,500 grams, and those who gave birth to babies weighing ≥ 2,500 grams were 88 people (36.21%). Meanwhile, there were 164 pregnant women who were not anemic, 9 people (5.4%) gave birth to low birth weight < 2,500 grams, and 155 people who gave birth to babies weighing ≥ 2,500 grams (63.79 %). Based on the results of the Chi-Square test, the *p* value was 0.004 (p < 0.05), so it was concluded that there was a significant relationship between anemia of pregnant women and the birth weight of the baby.

These results are in line with the research conducted by Wahyuni (2017) at the Puskesmas Trauma

Center Samarinda The results showed that there was a significant or positive relationship between hemoglobin levels of pregnant women in the third trimester and fetal body weight at the Trauma Center Puskesmas with a *p* value = 0.000.[10] Another study by Sekhavat (2011) in Iran examined maternal anemia that was associated with an increased risk of low birth weight significantly. This shows that there is a positive relationship between maternal hemoglobin levels and birth weight of babies.[11] Research by Sari in the working area of Pujer Health Center suggested that there is a relationship between hemoglobin levels of pregnant women in the third trimester and the weight of newborns in Bondowoso.[12] However, the results were not in line with the research conducted by Setiawan (2015) in Kota Pariaman which stated that there is no association between anemia in third trimester pregnant women and infant birth weight ($p > 0.05$).[13]

Table 3 shows that pregnant women who gave birth at DR. Tadjuddin Chalid Makassar City in 2018 who experienced anemia were 105 people, of which 41 people gave birth to babies with a body length < 48 cm (39.05%) and 64 people who gave birth to babies with a body length of 48-52 cm (60.95%) %). Meanwhile, there were 164 pregnant women who gave birth to babies with a body length < 48 (23.78%) and 125 people who gave birth to babies with a body length of 48-52 cm (76.22%). Based on the results of the Chi-Square test, the *p* value was 0.008 ($p < 0.05$), so it can be drawn that there was a significant relationship between anemia of pregnant women and the length of the baby's birth body.

This research was supported by previous research by Putri at RSPAD Gatot Soebroto Dietkesad in 2014 which suggested that there is a relationship between anemia in pregnant women and anthropometry of newborns which includes the length of the baby's body.[14] Another study by Kaur in India showed a positive correlation between anemia with the length of the baby's body.[15]

Table 4 shows that pregnant women who gave birth at DR. Tadjuddin Chalid Makassar City in 2018

Who have experienced anemia were 105 people, of which 16 people gave birth to babies with head circumference of < 32 cm (15.24%) and those who gave birth to babies with a head circumference of 32-37 cm were 89 people (84.76%). Meanwhile, there were 164 pregnant women who gave birth to babies with head circumference of < 32 cm (6.71%) and those who gave birth to babies with head circumference of 32-37 cm were 153 people (93.29%). Based on the results of the Chi-Square test, the *p* value was 0.023 ($p < 0.05$), so it was known that there was a significant relationship between anemia in pregnant women and the head circumference of newborns.

This study is supported by Kaur, who showed a positive correlation between maternal anemia and infant anthropometry, namely head circumference ($p = 0.003$).[15] Another study by Madaan (2015) in India noted a significant relationship between the degree of pregnant women and infant anthropometry ($p = 0.001$).[16] However , this study is not in accordance with the study by Hassan in Egypt which showed that there is no relationship between maternal anemia and size of the baby's birth which included the head circumference of

the newborn.[17]

Table 5 shows that pregnant women who gave birth in Dr. Tadjuddin Chalid Makassar City in 2018 who experienced of anemia were 105 people, of which 9 people gave birth to asphyxia babies (8.57%) and those who gave birth with normal *Apgar* score were 96 people (91.43%). Meanwhile, there were 164 pregnant women without anemia, and there were 5 people (3.05%) who gave birth to asphyxia and 159 (96.95%) who gave birth with normal *Apgar* score. Based on the results of the Chi-Square test, the *p* value was 0.088 (p> 0.05), so it was known that there was no significant relationship between anemia of pregnant women and the Apgar score of newborns.

Our research is in accordance with the results noted by Sibarani (2015) at RSU Artha Medica Binjai which showed that there is no relationship between anemia and *Apgar* score of newborns.[20] Other research by Azhari (2016) showed no differences between scores at the first and fifth minutes in term pregnancy with anemia and with no anemia.[18] Another study that is not in line with our study was done by Fatmasari (2015) at Ngudi Waluyo Wlingi-Blitar Regional Hospital regarding the effect of low anemia on the *Apgar* score of newborns.[18] Another study by Alizadeh (2014) in Iran suggested that there is a significant relationship in anemic mothers which shows a low risk of *Apgar* score.[19]

Conclusion

Based on the results of the research analysis, it can be concluded that there is a significant relationship between anemia of pregnant women with weight, body length, head circumference of newborns and there is no significant relationship between anemia of pregnant women and the *Apgar* score of newborns.

A limitation of this study is that we did not assess other factors that might influence the anthropometry of the newborn, such as genetics and maternal BMI during pregnancy.

The suggestion of the authors of the next study is that it will expects to study other factors that can affect the anthropometry of newborns more specifically, such as genetics, so that the results obtained are more accurate. In addition, HB levels were measured not only in the third trimester but from the beginning of pregnancy to identify the changes in anemia status in pregnant women.

Acknowledgment

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ORIGINAL ARTICLE　　　　　　　　　　　　　　　　　　　**Open Access**

Relationship between Nutritional Status and Development of Preschool Aged Children in the Operational Area of Puskesmas Batua Raya

Nuraeni Azizah[1]*, Darmawansyih[2], Henny Fauziah[3]

[1]Medicine Education Study Program, Faculty of Medicine and Health Sciences, Alauddin State Islamic University, Makassar, Indonesia

[2]Department of Biochemistry, Faculty of Medicine and Health Sciences, Alauddin State Islamic University, Makassar, Indonesia

[3]Department of Histology, Faculty of Medicine and Health Sciences, Alauddin State Islamic University, Makassar, Indonesia

*Corresponding Author. E-mail: nuraeniazizah18@gmail.com Mobile number: +6281248392016

ABSTRAT

Introduction: Development is a mental change that occurs gradually and over time, starting from simple abilities to more difficult abilities, such as attitude, behavior and intelligence. Preschool age is a golden age in which all aspects of development play an important role in aspects of further development. The study aimed to determine the relationship between nutritional status and development of preschool aged children in the operational area of Puskesmas Batua Raya.

Methods: The study used a cross sectional study design with total sample of 196 respondents. Data were collected through anthropometric measurements of body weight and KPSP assessment (developmental pre-screening questionnaire) was carried out. Data analysis was performed using the chi square test.

Results: Results of the study found that children with appropriate development were higher in good nutritional status (74%) than those who were below the nutritional status (5.6%). Analysis of the two variables shows the value of p = 0.000. Statistically, there was a significant relationship between nutritional status and development of preschool children.

Conclusion: Based on the research, it may be concluded that there is a relationship between maternal knowledge and the behavior of exclusive breastfeeding in the operational area of the Sudiang Primary Health Center.

Keywords: Nutritional Status; Development; KPSP; Body Weight

Introduction

Developing countries are generally occupied by 200 million children below 5 years old and more than a third of that number does not fulfill their development potential. Failure to fulfill the potential for child development is expected to hamper children ability to receive information and, by that, produce some effects on socializing in the community. Development of children in developing countries is influenced by several factors, namely inadequate early stimulation, severe chronic malnutrition, iron deficiency, anemia, and iodine deficiency. One of the important factors in development is nutritional status in children. Nutritional status is a measure for assessing the fulfillment of children's nutritional needs. Proper and balanced nutritional intake will affect the development, growth and intelligence of children [1].

According to Hadi (2019), the cost of nutritional status is an effort to interpret all information obtained through anthropometric research, food consumption, biochemistry and clinic. According to WHO in Hadi (2019), the nutritional status monitoring system can be carried out in the form of surveys, surveillance and screening. [2]

Data from the Indonesian Health Profile in 2014 reported that the prevalence between malnutrition and lower-nutrition had showed an increase from 2007 to 2013 on the nutritional status of children under five based on weight index for age (Body Weight / Age), weight for height (Body Weight / Height), and height according to age (height / Age) is obtained. [3]

Nationally, the prevalence of underweight is based on the results of Health Research Regional (Riskesdas) in 2013 was 19.6 percent, consisting of 5.7 percent of malnutrition and 13.9 percent of malnutrition. When compared with the national prevalence rate 2007 (18.4%) and 2010 (17.9%) were seen to increase. For the Province South Sulawesi data on Malnutrition + Underweight based on results Riskesdas was 17.6% (2007) increased to 25% (2010) and experienced again increase to> 25% (2013). [4]

The Ministry of Health of the Republic of Indonesia in 2018 reported that the results of measuring the growth and development of children were obtained (3.9%) who experienced malnutrition, (13.8%) malnutrition, (79.2%) good nutrition and (3.1%) excess nutrition. For the national scale, especially in South Sulawesi Province, namely (4.6%) experiencing malnutrition, (18.4%) malnutrition, (74.2%) good nutrition, and (2.9%) overnutrition. [5]

Prevalence of Underweight Children in 2019 by 11%, has exceeded the set target (22%) and decreased (performance increased) when compared to 2018 (18.10%). Achievements in 2019 when compared with national achievements still below the national prevalence, namely 17.7% (performance is higher than national achievements). However, even though South Sulawesi has succeeded reducing the prevalence rate on an ongoing basis is still necessary enhanced efforts that are more optimal in improving nutritional status community, especially in the toddler group. [6]

Preschool age is the golden age where all the aspects of development play an important role in aspects

of further development. Development of preschool children includes motor, social and language personal development. During the period of child development, there is a needed for guidance to match what is expected.[7]

Providing the proper nutrition can make children experience the right and appropriate development. Child development can be identified using two methods, namely the Denver II method and the KPSP method (Developmental Pre-Screening Questionnaire). As for this study, researchers employed the KPSP method to determine the development of preschool children. This was because the method is considered easier and faster in identifying the observed development cycle of the child. [8].

Based on the description above, the research was conducted with the aim of identifying the level of nutritional status of children, development of preschool children, and the relationship of nutritional status to the development of preschool children.

Methods

The study used an analytical method with a cross sectional design. Research design was used to determine the relationship between the dependent variable, namely nutritional status and the independent variable, namely child development. Research was conducted in January 2020 in the operational area of the Batua Raya Community Health Center. The population in this study was all preschool children in the operational area of Puskesmas Batua Raya. The sampling was carried out using non-probability sampling techniques, namely purposive sampling with a total sample of 196 which met the inclusion and exclusion criteria.

Data include primary data and secondary data. Primary data were obtained from direct anthropometric observations and measurements of preschool children and questionnaire assessments. Questionnaire sheet was the instrument used to determine the level of nutritional status on child development. This instrument presented in the form of statements adapted to the determined indicators. Statements can be divided into two, namely negative and positive statements. Secondary data were obtained from preschool age children in the operational area of the Batua Community Health Center. Data analysis was completed by bivariate analysis.

Bivariate analysis is an analysis carried out on two suspected related variables. The relationship of each variable was tested using the test chi square statistic with significance level ($\alpha = 0.05$). The purpose of the chi square test is to test for differences in proportions or percentages between different groups of data.

The data obtained were then analyzed using IBM SPSS 23 software. The analysis used the Chi-Square test to determine the relationship between dependent and independent variables.

Result

Result of the research showed that characteristics of the respondents include female respondents of 96 children (48.9%) and male of 100 children (51.1%). Characteristics of children regarding the gestational age and normal birth weight showed that there were as many as 196 children (100%) found for this area. There were 148 children with good nutritional status (74.5%), 8 children with poor nutrition (4.1%), 39 children with lower nutrition (19.9%), and 3 children with over nutrition (1.5%). There were 144 preschool children (73.5%) of the total 196 children who were at the appropriate development, while in the doubtful category there were 46 children (23.5%), and in the deviant category showed 6 children (3.0%).

Table 1. Distribution of Characteristics of Respondents Based on the Characteristics of Preschool Children (3-5 years) in the operational area of the Batua Raya Community Health Center in 2020 (N = 196)

Characteristics	n	%
Gender		
Male	100	51.1
Female	96	48.9
Age of Gestation		
Normal (37 - 42 Weeks)	196	100
Birth body weight		
Normal birth weight (2500 – 4000 grams)	196	100
Nutritional status		
Malnutrition	8	4.1
Poor nutrition	39	19.9
Good nutrition	146	74.5
Over nutrition	3	1.5
Preschool Age Child Development		
Appropriate	160	81.6
Doubted	30	15.3
Deviated	6	3.1

Table 1 explained that the respondents include 96 girls (48.9%), and 100 boys (51.1%). Respondents who had normal weight gestation were 196 children (100%). There were 146 children who experienced good nutrition (74.5%), 8 children (4.1%) had malnutrition, 39 children (19.9%) had poor nutrition, and as much as 3 children (1.5%) in the category of over nutrition. Also, there were 160 children (81.6%) of preschoolers who were in appropriate development from a total of 196 children, while as many as 30 children (15.3%) were in doubted category, and 6 children (3.1%) were in deviated category.

Table 2. Relationship between nutritional status and child development.

Nutritional Status	Development Status						Total		Value
	Appropriate		Doubted		Deviated				
	n	%	n	%	n	%	n	%	
Over	3	1.5	-	-	-	-	3	1.5	0.000
Good	145	74	-	-	1	0.5	146	74.5	
Poor	11	5.6	26	13.3	2	1	39	19.9	
Malnutrition	1	0.51	4	2.04	3	1.53	8	4.1	
Total	160	81.6	30	15.3	6	3.1	196	100	

Based on Table 2, children who were in the over nutritional status showed development status of 1.5% (3 respondents). Good nutritional status with an appropriate development status were 74% (145 respondents), and only 0.5% (1 respondent) in the deviated category. In the poor nutrition status, there were 5.6% (11 respondents) at the appropriate development status, 13.3% (26 respondents) at the doubted, and 1% (2 respondents) in the deviated category. Meanwhile, malnutrition showed 0.5% (1 respondent) was in the appropriate developmental status, 2.04% (4 respondents) in the doubted, and 0.51% (1 respondent) in the deviated category.

Discussion

Data from the results of research using children in the age period of 3-5 years in the working area of the Batua Raya Community Health Center found that there was a relationship between nutritional status and development of preschool children. This conclusion is in line with that found in the research by Wauran, et.al. (2016) in the study titled the "Relationship Between Nutritional Status and Gross Motor Development of Children aged 1-3 years in Bitung Village, Amurang District, Minahasa Regency," which showed a relationship between nutritional status and gross motor development [3]

Meanwhile, the research was conducted by Kusuma (2013) et al showed that there was no relationship between nutritional status and child development. Based on this research, nutritional status had several factors that affect child development, such as maternal work, and development because their parents leave them for work. [9]

Several reasons that may affect the nutritional status of children include child care patterns, food intake, and infectious diseases. When a child gets enough good food intakes, but often attacked by infectious diseases, their nutritional status will be severely affected. Likewise, children who were provided with inappropriate food may have a weak immune system and, ultimately, affect their nutritional status. Parenting patterns may take the form of attitudes and behavior of mothers or other caregivers in terms of their closeness to children, providing food, caring for, cleanliness, affection and so on [10].

In Islam, this has been explained in Q.S An-Nisa / 4: 9

<div dir="rtl">

سَدِيْدًا قَوْلًا وَلْيَقُوْلُوا اللهَ فَلْيَتَّقُوا عَلَيْهِمْ خَافُوْا ضِعْفًا ذُرِّيَّةً خَلْفِهِمْ مِنْ تَرَكُوْا لَوْ الَّذِيْنَ وَلْيَخْشَ

</div>

Translation: And, fear Allah those who in case leave behind them weak children, whom they fear for their (welfare), therefore let them fear Allah and let them speak the right word.[11]

According Shibab (2016) in Tafsir Al-Mishbah, the interpretation above explained that "weak children" in this case are weak physically, materially, and mentally. Therefore, Allah SWT forbids us to leave weak children.[12]

In this study, nutritional status was measured using body weight for age. The parameters used to provide an image of body mass are carried out by measuring body weight. Body mass is very sensitive to sudden changes, for example exposure to infectious diseases, decreased appetite, and decreased food consumption. In normal circumstances when there is a balance between consumption and nutritional needs, body weight can develop with age. Conversely, in an abnormal condition there are two possibilities for weight development, namely that it can develop sooner or later than normal. This also affects development. When children are deficient in nutrients, cell division will result in a maximum reduction of brain cells which can result in developmental delays. Providing optimal nutrition will cause development to be appropriate [13]

Development is the increasing ability and function of the body to become more complex over time, which can be obtained from the process of differentiation of cells, body tissues, organs and their organized systems. Child development consists of physical, cognitive, emotional, language, motor (gross and fine),

social and adaptive personal development. According to Frankerburg (1961) there are four aspects of the development of children under five, namely personality, fine motor skills, gross motor skills and language.[14] To assess children's development, an assessment was carried out using the Developmental Pre-Screening Questionnaire (KPSP) covering the development of personality, fine motor skills, gross motor skills and language adjusted to the age of the child concerned. In the sample, the Developmental Pre-Screening Questionnaire (KPSP) covering the development of personality, fine motor skills, gross motor skills and language adjusted to the age of the child concerned. In the sample, the development of preschool-aged children was measured using the KPSP method[15]

The study has some limitations. This is caused by examination based on the nutritional status on the body weight for age, while there are several other techniques that were related but not studied, such as: anthropometry, clinical, biochemical, and biophysical. Therefore, to optimize the results of research, these techniques can also be employed. In addition, the children also found it difficult to execute the directions, while the parents were very helpful in the research. Researchers did not examine several factors related to the development of preschool children such as stimulus provided by parents, family economic income, and

parental education which limited the discussion of the study.

Conclusion

There is a relationship between nutritional status and development of preschool aged children in the working area of Puskesmas Batua Raya.

Conflicts of Interest

No potential conflict of interest relevant to this article was reported.

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ORIGINAL ARTICLE   **Open Access**

Relationship between Mother's Knowledge of Breastfeeding and Exclusive Breastfeeding for Nursing Mothers in the Operational Area of the Sudiang Primary Health Center

Dian Wahyuni[1]*, Rosdianah[2], Asriani[3]

[1]Medicine Education Study Program, Faculty of Medicine and Health Sciences, Alauddin State Islamic University, Makassar, Indonesia

[2] Department of Anatomy, Faculty of Medicine and Health Sciences, Alauddin State Islamic University, Makassar, Indonesia

[3] Department of Physiology, Faculty of Medicine and Health Sciences, Alauddin State Islamic University, Makassar, Indonesia

*Corresponding Author. E-mail: dian22wahyuni@gmail.com, Mobile number: +6282240811429

ABSTRACT

Introduction: Exclusive breastfeeding is breastfeeding only in the first six months without drinks or other additional foods. Several factors influence breastfeeding behavior, one of which is the mother's knowledge. This research was conducted to determine whether there is a relationship between maternal knowledge and exclusive breastfeeding behavior

Methods: The study used an analytic observational study design with a cross-sectional approach. The research sample was breastfeeding mothers who have children aged 6-24 months in the operational area of Sudiang Primary Health Center. Samples were taken using purposive sampling technique with a total sample of 262 people. Data was collected by filling out questionnaires by respondents.

Results: Results showed that mothers with high knowledge and provide exclusive breastfeeding were more than 56.1%. Analysis of the two variables shows the value of $p = 0.000$. Statistically, there is a significant relationship between maternal knowledge and exclusive breastfeeding behavior.

Conclusion: Base on the research, it may be concluded that there is a relationship between maternal knowledge and the behavior of exclusive breastfeeding in the operational area of the Sudiang Primary Health Center.

Keywords: Maternal Knowledge; Breastfeeding; Exclusive Breastfeeding

Introduction

Breast milk (BM) is a mixture of protein and fat in a carbohydrate-mineral solution. Breastfeeding mothers can quickly produce 600 ml of milk every day, where the quality or quantity of breast milk is not affected by a woman's weight during pregnancy.[3]

Exclusive breast milk (BM) is the provision of breast milk only to babies in the first 6 months of birth without fluids or other solid foods and even water except for oral rehydration solutions, or syrups/drops of vitamins, minerals or medicines.[17]

Importance of breastfeeding babies can be explained scientifically as the Holy Qu'ran also describes the instructions to give breast milk to children. This is explained in the Al Baqarah / 2: 233.

﴿۞وَٱلْوَٰلِدَٰتُ يُرْضِعْنَ أَوْلَٰدَهُنَّ حَوْلَيْنِ كَامِلَيْنِ لِمَنْ أَرَادَ أَن يُتِمَّ ٱلرَّضَاعَةَ......ۚ﴾

Translation: "Mothers should breastfeed their children for two full years, that is, for those who want to complete breastfeeding ...."[4]

This verse fragment explains that the best food for babies is breast milk until they are two years old. From birth, mothers are instructed to breastfeed up to two full years of age for those who wish to complete breastfeeding for their children. Two years is not an obligation even though it is ordered, but a strongly emphasized recommendation is to be carried out, as if this is an obligatory order.[15]

Data from the Basic Health Research (Riskesdas) in 2018 shows that the percentage of babies in Indonesia who receive exclusive breastfeeding is still very alarming, namely 37.3%. This confirms that there is still a lack of exclusive breastfeeding in the first 6 months where the success target of exclusive breastfeeding set by the Ministry of Health is 80%. The percentage of exclusive breastfeeding in South Sulawesi has increased and, also, decreased from year to year. In 2011, exclusive breastfeeding coverage was 41.32%, then increased in 2012 by 62.70% and decreased again in 2014 by 56.31%. The number of babies who were exclusively breastfed in 2015 in the city of Makassar with 43 Primary health centers showed the percentage of babies breastfed for up to 6 months was only 72.43%.[8,16]

Several Health Center operational areas in the city of Makassar showed success rates of exclusive breastfeeding under the national standard. Where the Health Center with the lowest percentage of success was the Sudiang Primary Health Center with a percentage of exclusive breastfeeding of 27.39% (192 of 701 babies aged 0-6 months) while the highest success was the Dahlia Health Center with 96.7% (239 of 248 babies aged 0-6 months).[5] Based on this data, the percentage of exclusive breastfeeding at Sudiang Primary Health Center is far below the national target. This is what underlies the current study to determine the cause of the low level of exclusive breastfeeding in the operational area of the Sudiang Primary Health Center.

Exclusive breastfeeding is the best food source for babies. However, several obstacles can hinder the process, including low knowledge of mothers about the breastfeeding's benefits for babies and correct

methods of lactation, less milk production, on the first day of birth the baby is already getting prelacteal feeding (sugar water / formula), nipple abnormalities in mothers, babies having difficulty sucking, pregnant women again while still breastfeeding their babies, having to leave babies at home because mothers go to work, the need to be perceived as modern people, and the influence of incessant advertisements for formula milk.[12]

Knowledge level is affected by age, education and occupation. When viewed from a quality perspective of human resources, education problem in Indonesia is still very far from being compared to other countries. World Education Ranking data published by the Organization for Economic Cooperation and Development (OECD), which outlines the position of a country in terms of education, showed that Indonesia ranks 69th out of 75 countries.[11] Based on the data obtained, the level of education in Indonesia is still deficient, this is the basis for this study to determine whether there is a relationship between maternal knowledge about breastfeeding and exclusive breastfeeding for breastfeeding mothers who have children aged 6-24 months in the operational area of the Sudiang Primary Health Center.

Breastfeeding does not only have a positive impact on the baby but also on the mother. Breast milk is the best source of nutrition for the baby's growth and development process. Apart from being a nutrient, breast milk also plays a role in protecting babies from various diseases caused by infection, enhancing the immune system, increasing intelligence, and reducing the incidence of diarrhea in infants. Apart from it benefits for the baby, breastfeeding is also beneficial for the mother, such as strengthening the bond between the child and the mother, improving uterine contractions, and being a natural family planning for the mother/giving distance subsequent pregnancy.[13]

Based on the description above, the current study aimed to determine the knowledge level of breastfeeding mothers regarding the content, benefits, methods of giving and duration of breastfeeding, the success rate of exclusive breastfeeding, and the relationship between maternal knowledge and exclusive breastfeeding. The novelty of this study is a study using a sample of 6-24 months of age, because it has passed the entire breastfeeding period so that the related results are more accurate or not exclusive breastfeeding. Besides, this study uses a larger sample than previous studies.

Methods

This research is quantitative research using the non-random sampling technique purposive sampling type. This research was conducted in the operational area of the Sudiang Primary Health Center, Biringkanaya District, Makassar City, in January 2020. The sample used in this study was 262 respondents. In this case, the selected sample meets the criteria determined by the researcher. There are two categories of criteria, namely inclusion and exclusion criteria. Inclusion criteria are respondents who have babies aged 6-24 months, mothers who live with their children, and respondents who live in the working area of the

Sudiang Primary Health Center. At the same time, the Exclusion Criteria are mothers who do not breastfeed for medical reasons or illness, such as mothers suffering from infectious diseases (HIV / AIDS, tuberculosis, hepatitis B), anatomical abnormalities (inverted nipple), children who have congenital abnormalities such as labioschisis or palatoschisis.

Data used in this study are primary data. Primary data was obtained through direct data collection in the operational area of the Sudiang Primary Health Center. The data analysis used bivariate analysis. Hypothesis testing was completed by the chi-square test method to determine whether there is a relationship between the dependent variable and the independent variable at the 95% confidence level.

Result

Table 1 Frequency Distribution of Respondent Characteristics based on Mother's Age, Mother's Education, Mother's Occupation, and Age of Babies in the Operational Area of the Sudiang Primary Health Center in 2020

Characteristics		Frequency	Percentage (%)
Mother's Age	12 - 16 years old	1	0.4
	17 - 25 years old	120	45.8
	26 – 35 years old	118	45.0
	36 – 45 years old	20	7.6
	46 – 55 years old	3	1.1
Mother's Education	Elementary (SD)	36	13.7
	Junior high (SMP)	68	26.0
	Senior high (SMA)	116	44.3
	Academy/S1	42	16.0
Mother's Occupation	Housewife	178	67.9
	Self-employed	68	26.0
	Civil Servant	16	6.1
Age of Babies	6 – 12 months	159	60.7
	13 – 18 months	54	20.6
	19 – 24 months	49	18.7

Table 1 shows that the characteristics of the most of respondents are between 17 and 25 years old, as many as 120 people (45.8%), senior high school education is 116 people (44.3%), respondents work as housewives (IRT) as many as 178respondents (67.9%) and the age of the baby of the most respondents between the ages of 6-12 months were 159 people (60.7%).

Table 2 Knowledge Distribution of Breastfeeding Mothers in the Operational Area of the Sudiang Primary Health Center in 2020

Knowledge	Frequency	Percentage (%)
Good	188	71.7
Not good	78	28.3
Total	**262**	**100**

Table 2 shows that breastfeeding mothers with a good level of knowledge were 188 people (71.7%), and poor level of knowledge were 78 people (28.3%).

Table 3 Distribution of Exclusive Breastfeeding in the Operational Area of the Sudiang Primary Health Center in 2020

Exclusive Breastfeeding	Frequency	Percentage (%)
	159	60.7
	103	39.3
Total	**262**	**100**

From the table above, it can be seen that 159 breastfeeding mothers conduct exclusive breastfeeding (60.7%) while 103 people do not give exclusive breastfeeding (39.3%).

Table 4 Results of Mother's Knowledge Relationship Test with Exclusive Breastfeeding in the Sudiang Primary Health Center Operational Area in 2020

Mother's Knowledge	Breastfeeding						P-Value
	Exclusive		Non-Exclusive		Total		
	∑	%	∑	%	∑	%	
Good	147	56.1	41	15.6	188	71.7	
Not Good	12	4.6	62	23.7	74	28.3	**0.000**
Total	**159**	**80.1**	**103**	**19.9**	**262**	**100**	

Table 4 shows that respondents with good knowledge and conduct exclusive breastfeeding to babies were 147 people (56.1%) and respondents with good knowledge but do not conduct exclusive breastfeeding to babies were 41 people (15.6%). Meanwhile, respondents with poor knowledge but who were exclusively breastfeeding their babies were 12 people (4.6%), and respondents with poor knowledge and did not conduct exclusive breastfeeding for babies were 62 (23.7%).

Results of statistical tests by Chi-square on the variables of mother's knowledge about breastfeeding and the variable of exclusive breastfeeding, using *p*-value of 0.000 (<0.05) indicated that H_0 was rejected / H_1 was accepted, which means that there was a significant relationship between mother's knowledge on breastfeeding and exclusive breastfeed in the operational area of the Sudiang Primary Health Center. The following chart provides more details:

Graph 1 Test Results of Mother's Knowledge Relationship with Exclusive Breastfeeding
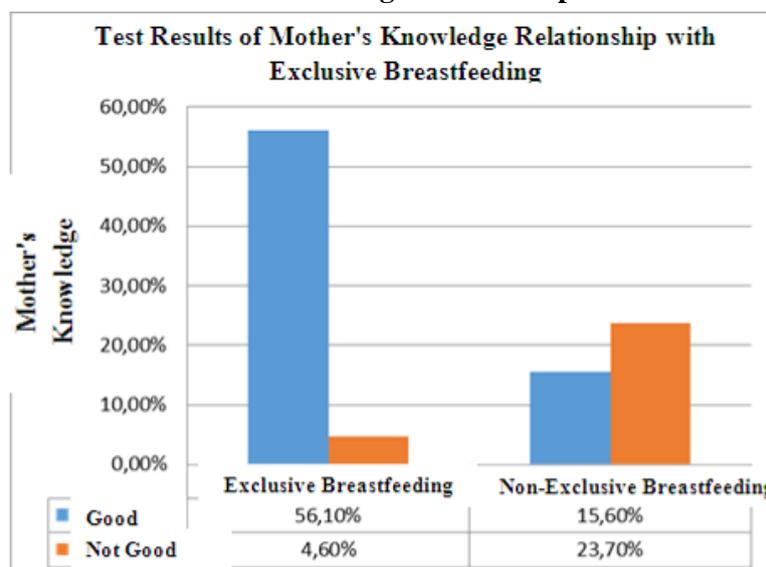
Discussion

This study was conducted by measuring the level of mother's knowledge on the breastfeeding based on exclusive breastfeeding application to 262 mothers. Results showed that mothers with good knowledge were 188 mothers (71%), where 147 mothers (56.1%) gave exclusive breastfeeding and 41 mothers (15.6%) did not exclusively breastfeed their children. Meanwhile, 78 mothers (28.2%) had poor knowledge, where 12 mothers (4.6%) gave exclusive breastfeeding and 62 mothers (23.7%) did not exclusively breastfeed their children.

Based on this study, it can be proven that the level of knowledge of mothers about breastfeeding affects the act of exclusive breastfeeding. According to Budiman (2016), several factors several factors influence, among others, education, information obtained from social media, culture and economy, environment, individual experience, and age. Education is used to obtain the information to improve the quality of life by being considered a human guide to act and fill life.[6]

Knowledge has a significant role in determining mother's behavior as knowledge will bring understanding to the mother about the good and bad effects of exclusive breastfeeding. This understanding will be the basis for mothers to behave in giving exclusive breastfeeding for their babies.[10]

The study results showed that the characteristics of respondents based on age indicated that most of the respondents were aged 17-25 years at 45.8% and ages 26-35 years at 45.0%. Regarding knowledge, mothers with this age range can be said to have the ability to digest various information obtained to increase their understanding of exclusive breastfeeding. The construction of mother's knowledge is also affected by the level of education. Results of the analysis on the characteristics of the research respondents revealed that the majority of respondents with high school education were 44.3%. A mother's education level affects the formation of a mindset that is open to new things. The more information the mother obtains, the better her level of knowledge. A person who has more information will have more knowledge too.[12] Based on Nainggolan (2016) research, education affects maternal knowledge, where a well-informed mother is a mother who is highly educated in the health sector, a more educated mother will encourage someone to seek more information about the things they experience.

Based on the results, it is showed that exclusive breastfeeding in the operational area of the Sudiang Primary Health Center was 60.7%. The result means that the majority of respondents have exclusively breastfed their babies but the percentage of this figure is still below the national target of 80%. Exclusive breastfeeding only provides breast milk to the baby and not given any other drinks or foods. Meanwhile, the respondents who did not exclusively breastfeed were 39.3%, namely 103 people.

Breast milk as natural food is the best food that mothers can provide to their newborn children so that they do not need additional food because all nutritional needs can be met from breast milk to ensure growth and development until the age of 6 months. Also, babies under six months of age have perfect digestive

enzymes that are not yet perfect, so they cannot digest food properly. Judging from the education level of the respondents, it is known that most of them have high school education at 44.3%. Higher levels of education will increase awareness of better health. Mothers with higher education already have a good mindset that is formed from the formal education process they go through so that it can influence behavior, one of which is manifested in exclusive breastfeeding.[9,14]

Exclusive breastfeeding has excellent benefits for babies, which can improve the baby's immune system and improve the baby's immune system and increase intelligence and increase the relationship between mother and baby.[16]

Table 4 shows a statistically significant relationship ($p<0.05$) between knowledge and exclusive breastfeeding by mothers who have babies aged 6-24 months in the operational area of the Sudiang Primary Health Center. With this, the hypothesis in this study proved that there was a relationship between knowledge and behavior of exclusive breastfeeding by mothers who have babies aged 6-24 months. These results may imply that expertise contributes significantly to the formation of complete breastfeeding practices. The results obtained in this study are in line with the theory which states that one's cognitive or knowledge is a factor that plays an essential role in shaping one's actions / behavior. From research and experience, it is proven that behavior based on knowledge shall be more durable when compared to behavior that is not based on knowledges.[10]

The study results are in line with the results of research conducted by Dian Aviyanti et al. entitled "The Relationship of Mother Education and Knowledge about Exclusive Breastfeeding and Attitudes Toward Exclusive Breastfeeding in 2012," which used 30 samples of breastfeeding mothers with children aged 0-6 months where the study results showed that there was a relationship between mother's knowledge and the attitude of exclusive breastfeeding.[2]

The importance of science is seen from its benefits, but as a Muslim, studying is an obligation that must be done, both for men and women. This is explained in the hadith of Sunan Ibn Majah No.220:

طَلَبُ اْلعِلْمِ فَرِيْضَةٌ عَلَى كُلِّ مُسْلِمٍ (رواه ابن ماجه)

Translation: "Demanding knowledge is an obligation for every individual Muslim" This hadith narrated by Ibn Majah explains that knowledge is essential for humans in the life of the world and the hereafter. Humans will not be able to live this life without knowing. Even what makes humans have advantages among other God's creatures is because humans have knowledge.[7]This hadith shows the similar meaning with the results of this study, wherein this hadith it has been explained that a Muslim's obligation to follow knowledge, if someone is knowledgeable, then he will understand between bad behavior and good behavior. A mother who has a good understanding of breast milk may exclusively breastfeed her child.

Several reasons and cultural factors are inherent in society that support a mother often giving supplementary food to her baby at <6 months of age. Mother's behavior to provide exclusive breastfeeding

will only be formed if a mother has the correct knowledge about exclusive breastfeeding, including the definition, reasons for exclusive breastfeeding, the benefits and effects of not giving exclusive breastfeeding.[12] The results of this study indicated that the better a mother's level of knowledge, the better the exclusive breastfeeding behavior. Supported by the results of cross-tabulation, it is known that most of the respondents who have good knowledge give exclusive breastfeeding to their babies at 56.1% and mothers who have poor knowledge and do not give exclusive breastfeeding were 23.7%. This shows that knowledge contributes significantly to exclusive breastfeeding behavior.

The study showed that 41 respondents (15.6%) had good knowledge but did not conduct exclusive breastfeeding to the babies and as many as 12 respondents (4.6%) who had poor knowledge but gave exclusive breastfeeding to their babies. Several factors can affect the behavior of exclusive breastfeeding, including ability, education, mother's health / physical condition, family income, work, and getting support from family, community and the role of health workers to participate in explaining why mothers are about the importance of exclusive breastfeeding to babies.[1]

Based on the description above, mothers with good knowledge of exclusive breastfeeding pay better attention to the importance of exclusive breastfeeding for their babies and themselves. Thus, mothers with good knowledge apply more efforts into giving exclusive breastfeeding to their babies.

Conclusion

Research results lead to the conclusion that the level of knowledge of mothers about exclusive breastfeeding in the operational area of the Sudiang Primary Health Center was mostly in the good category, the practice of exclusive breastfeeding in the operational area of the Sudiang Primary Health Center was 60.7% and there was a significant relationship between maternal knowledge and giving exclusive breastfeeding in the operational area of the Sudiang Primary Health Center. Results of the Chi-Square analysis obtained a *p*-value of 0.000 (p <0.05).

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ORIGINAL ARTICLE **Open Access**

The Relationship between Nutritional Status of Pregnant Women and Stunted Children

Ida Royani[1], Nasrudin Andi Mappaware[2], Sidrah Darma[3], Nurfadhillah Khalid[4], Dian Fahmi Utami[5]*

1 Division of Nutrition/Faculty of Medicine/ Universitas Muslim Indonesia/Indonesia
2 Department of Obstetrics and Gynecology /Faculty of Medicine /Universitas Muslim Indonesia/Indonesia
3 Division of Nutrition / Faculty of Medicine /Universitas Muslim Indonesia/Indonesia
4 Department of Pharmacology / Faculty of Medicine / Universitas Muslim Indonesia/Indonesia
5 Faculty of Medicine / Universitas Muslim Indonesia/Indonesia
*Corresponding Author. E-mail: dian.fahmiutami@umi.ac.id, Mobile number: 085241828716

ABSTRACT

Introduction: The nutritional status of pregnant women has a significant impact on the fetus's health and development. Low birth weight can be caused by womb growth problems. Research in Nepal shows that babies with low birth weight have a higher risk of becoming stunted. West Sulawesi is the most populous province in Central Indonesia, with a population of 39.7%. In Mamuju District, West Sulawesi, the relationship between stunted babies and maternal nutritional status during pregnancy was investigated.

Methods: Cross sectional analytic survey with a retrospective approach. Data processing using the chi square test. The population in this study was 20.039 people. Total sampling was used to collect nutritional status data of children under the age of five in West Sulawesi province from February to June 2020. In this study, 88 people were sampled, all of whom were mothers of stunted children aged 2 to 5 Years old and who had a KIA book during pregnancy.

(Continued on next page)

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Results: The results of statistical tests showed that the p value of nutritional status with BMI and LILA 0.000 and the p value of HB levels 0.066. There was a link between pregnant women's nutritional status and LILA, but not between HB levels and stunting.

Conclusion: The conclusion of this study is that there is a relationship between the nutritional status of pregnant women based on BMI and LILA and the incidence of stunting in Mamuju Regency, West Sulawesi Province.

Keywords: Nutritional status; BMI; stunting

Introduction

Nutritional issues must be considered even while the baby is still in the womb. The nutritional status of pregnant women has a significant impact on the growth and development of the fetus. Stunting or short children under the age of five are toddlers with chronic nutritional problems who have nutritional status based on length or height according to age when compared to the 2005 WHO-MGRS (Multicentre Growth Reference Study) standard, with a z-score of less than -2SD, and if the z-score is less than-3SD, they are classified as very short under five (Pusdatin, 2015).(1,2)

In developing countries, including Indonesia, nutrition is still a major public health problem and a cause of death for mothers and children. The mortality rate for infants and mothers and babies with low birth weight (LBW) is essentially also determined by the nutritional status of pregnant women. Pregnant women with poor nutritional status or experiencing KEK (Chronic Energy Deficiency) tend to give birth to LBW babies and are faced with a greater risk of death compared to babies born to mothers with normal weight. There are several ways that can be used to determine the nutritional status of pregnant women, including monitoring weight gain during pregnancy, measuring the upper arm circumference (LILA), and measuring HB levels.(3,4)

The health and development of the fetus are greatly influenced by the nutritional status of pregnant women. Low birth weight can be caused by womb growth problems (WHO, 2014). Babies born with a low birth weight have a higher risk of becoming stunted, according to Nepalese research (Paudel, et al., 2012). Stunting is also linked to the length of time a baby spends in the womb. According to research conducted in Kendal, babies born with short birth lengths have a higher risk of stunting as toddlers (Meilyasari and Isnawati, 2014). Exclusive breastfeeding for children under the age of five is another factors linked to toddlers stunting who are not exclusively breastfed for 6 months have a high risk of stunting, according to research conducted in Southern Ethiopia (Fikadu, et al., 2014).(5–8)

In Indonesia, East Nusa Tenggara is a province with the highest prevalence of infants with stunting,

namely 42.6% (Riskesdas, 2018). The province with the second largest stunted infants in Indonesia is West Sulawesi and is the highest province in Central Indonesia, reaching 39.7%. This number consists of very short toddlers reaching 14.7% and 25% short toddlers. (9,10)

Because of the high incidence of stunting in Central Indonesia, particularly in West Sulawesi Province and Mamuju Regency, the authors are interested in conducting research on the relationship between maternal nutritional status during pregnancy and the incidence of stunting babies in Mamuju Regency, West Sulawesi, in order to reduce stunting in the West Sulawesi region.

Method

This type of research is an analytical survey. The research design used was a cross sectional approach (cross sectional) with a retrospective approach in which the cause and effect variables (related and independent variables) were measured at the same time and moment (point time approach).

The study took place in the Mamuju Regency of West Sulawesi Province. According to LP2S UMI's schedule, the research took place between February and June 2020. The study's participants were stunted children in Mamuju Regency, West Sulawesi Province. The population in this study was 20.039 people. The sampling technique used in this study was total sampling, with a total sample size of 88 people who met the inclusion criteria of mothers with stunted children aged 2 to 5 Years and who had a KIA book during pregnancy. Questionnaires and observation sheets were used as data collection instruments in this study. The chi square test was used in this data analysis.

The operational definition of stunting in this study is children aged 2-5 Years with nutritional status based on Body Length (BL)/ Age (A) or Body Height (BH) / Age (A) z-score <-2SD to -3SD for short status and <-3SD for very short status. Circumference of the upper arm (LILA) is a measurement of the nutritional status of pregnant women by measuring the circumference of the upper arm, which is divided into normal 23-33 cm, under nutrition <23 cm and over nutrition> 33 cm. BMI (Body Mass Index) is a measurement of the nutritional status of pregnant women by measuring body weight (kg) and height (m2). Hemoglobin levels are blood hemoglobin levels with normal levels> 10.5 mg/dl.

Results

The results of this stunting study were derived from simple random sampling of data on the nutritional status of children under the age of five in West Sulawesi province in February-June 2020. In this study, a total of 88 people were sampled, all of whom were mothers with stunted children aged 2 to 5. The age range was chosen because the effect of malnutrition on height takes a long time to manifest.

In this study, preliminary data were obtained regarding the nutritional status of children in West Sulawesi Province as follows:

Table 1. Initial nutritional status data for children in West Sulawesi based on their height and age.

Regency/City	Very Short				Short				Normal			
	0-2 Years		2-5 Years		0-2 Years		2-5 Years		0-2 Years		2-5 Years	
	L	P	L	P	L	P	L	P	L	P	L	P
Majene	335	221	797	622	396	314	967	916	1354	1302	1687	1646
Polewali Mandar	467	285	1341	980	998	673	2447	2037	4315	4109	6419	5892
Mamasa	219	113	460	289	308	222	799	615	1234	1089	2646	2419
Mamuju	470	393	869	740	347	264	640	580	2766	2467	3861	3366
Mamuju Utara	195	85	456	339	273	186	921	752	1720	1690	2981	2854
Mamuju Tengah	33	19	116	72	81	37	198	152	541	465	1080	841
Total	1719	1116	4039	3042	2403	1696	5972	5052	11930	11122	18674	17018

Source: Primary Data

Table 2. Nutritional characteristics of pregnant women with stunted babies based on BMI

Characteristics	n	%
Body Mass Index		
Less	53	60.2
Normal	32	36.4
Overweight	3	3.4
Obesity	0	0
Circumference of The Upper Arm		
Less	59	67.0
Normal	29	33.0
Obesity	0	0
HB		
No Anemia	76	86,4
Anemia	12	13,6
Total	88	100.0

Source: Primary Data

Based on table 2, the data shows that the characteristics of the nutritional status of mothers during pregnancy based on BMI were 53 people (60.2%) with low nutritional status. As many as 32 people (36.4%) with normal nutritional status distribution and 3 people (3.4%) with overweight nutritional status.

The characteristics of nutritional status based on LILA were 59 people (67%) with low nutritional status and as many as 29 people (33%) with normal nutritional status based on measurements of upper arm circumference.

Characteristics of nutritional status based on hemoglobin levels as many as 76 people (86.4%) with HB levels were not anemia and as many as 12 people (13.6%) with hemoglobin levels showed anemia.

The relationship between stunting based on the observed nutritional status includes: BMI, LILA and HB levels can be seen from the following tables:

Table 3. Analysis of the effect of nutritional status based on BMI on the incidence of stunting

Nutritional Status	Stunting				Total		p
	Short		Very Short				
	N	%	n	%	n	%	
Less	5	5,68	48	54,54	53	60,22	
Normal	28	31,82	4	4,55	32	36,37	
Overweight	3	3,41	0	0	3	3,41	0.000
Obsesity	0	0	0	0	0	0	
Total	**36**	**40.91**	**52**	**59.09**	**88**	**100.0**	

Sources: Primary Data

Based on the primary data in table 3, it was found that with low nutritional status based on BMI, it is found that the group of mothers with a BMI less than 52 people with 48 people (54.54%) having very short babies and 5 people (5.68%) with short babies. Whereas in the group of mothers with normal BMI as many as 32 people with 28 people (31.82%) having short babies and 4 people (4.55%) with very short babies. In the group of mothers with overweight (more) BMI as many as 3 people with 3 people (3.41%) having short babies. The statistical test yielded a p value of 0.05, indicating that there is a link between maternal nutritional status and the incidence of stunting during pregnancy, as measured by BMI.

Table 4. Analysis of the effect of nutritional status based on LILA on the incidence of stunting

Nutritional Status	Stunting			p
	Short	Very Short	Total	

	n	%	n	%	n	%	
Less	8	9,10	51	58	59	67,1	
Normal	28	31,82	1	1,14	29	32,9	0.000
Obesity	0	0	0	0.0	0	0	
Total	**36**	**40.9**	**52**	**59.1**	**88**	**100.0**	

Sources: Primary Data

Based on the primary data in table 4, it is found that with a malnutrition status based on LILA, it is found that the group of mothers with less nutritional status is 59 people with 51 people (58%) having very short babies and 8 people (9.10%) with short babies. While in the group of mothers with normal nutritional status as many as 29 people with 28 people (31.82%) having short babies and 1 person (1.14%) with very short babies. The statistical test yielded a p value of 0.05, indicating that there is a link between maternal nutritional status during pregnancy as measured by LILA and the incidence of stunting.

Table 5. Analysis of the effect of nutritional status based on HB to the incidence of stunting

Nutritional Status	Stunting				Total		p
	Short		Very Short				
	n	%	n	%	n	%	
Non Anemia	34	38,63	42	47,73	76	86,36	0.066
Anemia	2	2,28	10	11,36	12	13,64	
Total	**36**	**40,91**	**52**	**59,09**	**88**	**100,00**	

Sources: Primary Data

Based on the primary data in table 5, it is found that with less nutritional status based on HB levels, 76 people with HB levels are not anemic with 42 people (47.73%) having very short babies and 34 people (38.63%) with babies. short. Whereas in the group of mothers with anemia as many as 12 people with 10 people (11.36%) having very short babies and 2 people (2.28%) with short babies. The results of statistical tests showed that the value of p => 0.05, which means that there is no relationship between maternal nutritional status based on HB levels during pregnancy and the incidence of stunting.

Discussion

Stunting is a complex health problem, which can be linked by several factors that are currently still developing, such as health, economic, social and cultural factors. As in this study, data from various factors

were obtained from respondents both from medico social factors, medico obstetra and nutritional status which focused on the condition of the mother during pregnancy.

The mother's nutritional status was determined using her LILA during pregnancy, her BMI, and her HB level. Based on the results of statistical tests, a p value of 0.05 was obtained, indicating that there is a significant relationship between pregnant women's nutritional status as measured by LILA and BMI and stunting status in children aged 2 to 5 Years in Mamuju district, West Sulawesi Province. This is in line with Ringgo et al's (2019) findings, which show that the incidence of stunting is linked to the nutritional status of mothers during pregnancy. In another study also conducted by Sukmawati (2018), it was stated that there was a relationship between the nutritional status of mothers during pregnancy and the incidence of stunting and LBW. (11,12)

The statistical test of the relationship between maternal HB levels during pregnancy yielded a p value > 0.05, indicating that there is no significant relationship between HB levels and stunting status in Mamuju Regency children aged 2 to 5. This is in line with a study conducted in Semarang by VindaNur et al (2019), which found no link between HB levels and the incidence of stunting. Another study conducted in Yogyakarta by Kristiana et al (2016) found no link between maternal hemoglobin levels during pregnancy and the incidence of stunting in children. Factors that can affect hemoglobin levels are the intake of nutrients such as vegetables, fruits and foods that contain iron. (13,14)

A healthy baby is more likely to be born if the mother's nutritional status is good during pregnancy. The nutritional status of pregnant women, like that of the general population, is a physical condition that results from the consumption, absorption, and utilization of various macro and micronutrients. Because the pregnancy process causes physiological changes including hormonal changes and increased blood volume for fetal development, pregnant women must also increase their nutrient intake to meet these needs (Ministry of Health, RI 2018). The incidence of stunting is also influenced by various factors from the child, such as the presence of infectious diseases, exclusive breastfeeding, and the nutritional intake obtained.(13–15)

Conclusion

According to the findings, there was a link between maternal nutritional status during pregnancy as measured by BMI and LILA and the incidence of stunting, but no link between nutritional status as measured by HB levels and the incidence of stunting in Mamuju Regency, South Sulawesi Province.

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