Deanship of Graduate Studies

Al-Quds University

Risk Factors of Meningitis among Children in Gaza Governorates: Case-Control Study

Ahmed Yousef Al Malahy

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Prepared By

Ahmed Yousef Al Malahy

Bachelor of Nursing-PalestineCollege of Nursing

Palestine

Supervisor: Prof. Dr. Yousef Aljeesh

Professor of Public Health - The Islamic University of Gaza

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Prepared by: Ahmed Yousef Al Malahy
Registration No.: 21411273

Supervisor: Prof. Dr. Yousef Aljeesh

Master thesis submitted and accepted. Date: / /

The names of signatures of the examining committee members are as follows:

1. Prof. Dr. Yousef Aljeesh Head of committee ....
2. Dr. Khitam Abu Hamad Internal examiner ....
3. Dr. Anwar Shaikh Khalil External examiner ....

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Dedication

I would like to convey my sincere gratitude to my wife and my children who encouraged me all the way through this study, without their support, this work wouldn't reach the end.

Special thanks to my father, my mother, my brothers and sisters for their support which provided me with the energy to complete my study.

I would like to express my appreciations to all those who contributed to the completion of this thesis.

Ahmed Al Malahy

Acknowledgement

First of all, praise to Allah, the lord of the world, and peace and blessings of Allah be upon our prophet Muhammad, all thanks for Allah who granted me the capability to accomplish this thesis.

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I had the great opportunity to complete this study under the supervision, and guidance of Prof. Yousef Aljeesh.

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To my friends, and all those who contributed to the completion of this study, thank you very much.

Ahmed Yousef Al Malahy

August, 2018

Declaration

I certify that this thesis submitted for the degree of Master is the result of my own research, except where otherwise acknowledged, and this study (or any part of the same) has not been submitted for a higher degree to any other university or institution.

Signature:

Ahmed

16./8/2018

Abstract

Meningitis is one of the most significant infections in children, and despite the availability of newer antibiotics and preventive strategies, it remains an important cause of morbidity and mortality in developing countries. This case-control study aimed to identify the associated risk factors of meningitis among children in Gaza governorates. The sample of the study consisted of 174 children aged between one month to 12 years divided equally into two groups (case group) included 87 children admitted to pediatric wards with confirmed diagnosis of any type of meningitis and (control group) included 87 children without meningitis selected from out-patient department in the assigned governmental hospitals (Kamal Odwan, Al-Nassr pediatric hospital, Al Dora, Shohada Al Aqsa, European Gaza hospital, and Al-Tahreer maternity and pediatric hospital). Matching between the two groups with gender, age group, and place of treatment was considered during selection of participants. For data collection, the researcher used self-administered questionnaire developed by the researcher, and data was collected through interviews with mothers and using medical records. For data analysis, the researcher used SPSS (version 20), and statistical analysis included frequencies, percentage, means, standard deviation, cross-tabulation, and odds ratio.

The results showed that among children from case group and control group 44.8% vs. 43.7% live in camps, and 25.3% vs. 10.3% live in extended family. Bivariate analysis showed that significant risk factors for meningitis included living within extended family [OR 2.933, 95% CI (1.263 - 6.812), P= 0.012], preterm birth [OR 2.860, 95% CI (0.970 – 8.430), P= 0.057], history of head trauma [OR 3.828, 95% CI (1.447 – 10.132), P= 0.007], anemia [OR 1.997, 95% CI (0.984 – 4.051), P= 0.055], family history of meningitis [OR 4.226, 95% CI (1.491 – 11.975), P= 0.007], presence of smokers inside the house [OR 2.692 95% CI (1.456 – 4.976), P= 0.002], exposure to passive smoking [OR 2.402, 95% CI (1.257 – 4.528), P= 0.007], presence of animals indoor [OR 2.036, 95% CI (1.081 – 3.833), P= 0.028], and coming in contact with animals [OR 2.282, 95% CI (1.073 – 4.852), P= 0.032], using municipal water [OR 5.022, 95% CI (1.049 – 24.047), P= 0.043], and playing with other children in the street [OR 2.744, 95% CI (1.332 – 5.654), P= 0.006]. Protective factors included mothers' age 30 years and above [OR 0.536, 95% CI (0.290 – 0.989), P= 0.046], fathers age 30 years and above [OR 0.473, 95% CI (0.258 – 0.867), P= 0.016], fathers' work [OR 0.448, 95% CI (0.238 – 0.842), P= 0.013], high family income [OR 0.327, 95% CI (0.127 – 0.842), P= 0.021], and having high number of children in the family [OR 0.204, 95% CI (0.085 – 0.486), P= 0.000]. Multivariate analysis showed that significant risk factors included history of head trauma, family history of meningitis, animal breeding inside the home, while protective factors included fathers' work, living in extended family, and higher number of children. In conclusion, the study raised the need for alleviating risk factors of meningitis which include prohibiting smoking inside the house, avoid passive smoking, good nutrition to avoid anemia, avoid breeding of animals and birds inside the house, and avoid contact with animals.

عنوان الدراسة: عوامل الخطر المؤدية لحدوث مرض التهاب السحايا لدى الأطفال في محافظات غزة: دراسة مقارنة.

إعداد: أحمد الملاحي

إشراف: أ. د. يوسف الجيش

ملخص الدراسة

يعتبر مرض التهاب السحايا (الأغشية المبطنة للدماغ) من الأمراض الخطيرة التي تصيب الأطفال، خاصة التهاب السحايا البكتيري. هدفت الدراسة الحالية إلى معرفة عوامل الخطر التي تؤدي لحدوث التهاب السحايا لدى الأطفال في محافظات غزة. تكونت عينة الدراسة من 174 طفلاً تراوحت أعمارهم بين شهر واحد إلى 12 عام مقسمين بالتساوي إلى مجموعتين: (مجموعة الحالات) تكونت من 87 طفلاً من الأطفال المنومين في أقسام الأطفال تم تشخيصهم بأي نوع من أنواع التهاب السحايا، و(مجموعة ضابطة) تكونت من 87 طفلاً من المراجعين في العيادة الخارجية ولا يعانون من التهاب السحايا، وقد تم اختيار أفراد عينة الدراسة من المستشفيات الحكومية التي تقدم خدمة رعاية الأطفال وضمت مستشفى كمال عدوان، مستشفى النصر للأطفال، مستشفى الدرة، مستشفى شهداء الأقصى، مستشفى التحرير، ومستشفى غزة الأوروبي، وقد تم مراعاة تماثل أفراد المجموعتين في كل من الجنس، المرحلة العمرية، ومكان العلاج عند اختيار أفراد عينة الدراسة.

لجمع البيانات فقد تم استخدام استبانة من إعداد الباحث، وقد تم عرض الاستبانة على مجموعة من المحكمين، كما تم إجراء دراسة استطلاعية على عشرة استبانات بهدف التأكد من صدق ومناسبة الاستبانة للتطبيق في هذه الدراسة، وقد قام الباحث بجمع البيانات من خلال أمهات الأطفال وملفاتهم الطبية. لتحليل البيانات فقد استخدم الباحث برنامج الرزم الإحصائية للعلوم الإنسانية (SPSS, 20)،

ومن المعالجات الإحصائية التي تم استخدامها: التكرارات، النسب المئوية، المتوسطات الحسابية، الانحراف المعياري، ونسبة الأرجحية.

أظهرت نتائج الدراسة أن 44.844.8% من أطفال مجموعة الحالات و43.7% من أطفال المجموعة الضابطة يسكنون في مخيمات اللاجئين، و25.3% من أطفال مجموعة الحالاتو 10.3% من أطفال المجموعة الضابطة يسكنون في أسرة ممتدة.

بالنسبة لعوامل الخطر التي تؤدي للإصابة بالتهاب السحايا، فقد بينت النتائج أن كل من العوامل التالية اعتبرت عوامل خطر وكانت دالة إحصائياً وهي: السكن في أسرة ممتدة [OR 2.933, 95% CI (1.263 - 6.812), P= 0.012]، الولادة المبكرة قبل 37 أسبوع [OR 2.860, 95% CI (0.970 – 8.430), P= 0.057]، التعرض لإصابة سابقة في الرأس [OR 3.828, 95% CI (1.447 – 10.132), P= 0.007]، فقر الدم [OR 1.997, 95% CI (0.984 – 4.051), P= 0.055]، تعرض أفراد آخرين من الأسرة للإصابة بالتهاب السحايا [OR 4.226, 95% CI (1.491 – 11.975), P= 0.007]، وجود مدخنين في البيت [OR 2.692 95% CI (1.456 – 4.976), P= 0.002]، التعرض الثانوي للدخان [OR 2.402, 95% CI (1.257 – 4.528), P= 0.007]، تربية الحيوانات والطيور في البيت [OR 2.036, 95% CI (1.081 – 3.833), P= 0.028]، ملامسة ومخالطة الحيوانات [OR 2.282, 95% CI (1.073 – 4.852), P= 0.032]، استخدام مياه البلدية[OR 5.022, 95% CI (1.049 – 24.047), P= 0.043]، واللعب مع الأطفال في الشارع [OR 2.744, 95% CI (1.332 – 5.654), P= 0.006].

بينما بينت النتائج أن العوامل التالية كانت عوامل حماية دالة إحصائياً وهي: الدخل الشهري العالي فوق خط الفقر [OR 0.327, 95% CI (0.127 – 0.842), P= 0.021] عمل الأب [OR 0.448,95% CI (0.238-0.842), P= 0.013]، وجود عدد كبير من الأفراد في الأسرة [OR

0.180, CI 95% (0.040 - 0.805), P= 0.025]، كما تبين أن عمر الوالدين 30 سنة فأكثر كان من عوامل الحماية الدالة إحصائياً (الأمهات P= 0.046، الآباء P= 0.016).

كما بينت نتائج تحليل الانحدار المتعدد أن كل من التعرض للإصابة في الرأس، إصابة أفراد آخرين من العائلة بالتهاب السحايا، وتربية الحيوانات والطيور في البيت كانت عوامل خطر للإصابة بالتهاب السحايا، في حين أن عمل الأب، السكن في أسرة ممتدة، ووجود عدد كبير من الأفراد في الأسرة كانت عوامل حماية.في الإجمال فقد أظهرت الدراسة الحاجة إلى الحاجة للحد من عوامل الخطر للمرض والتي تتمثل في عدم تدخين الآباء داخل المنزل، عدم تعرض الأطفال للتدخين الثانوي، التغذية الجيدة للوقاية من فقر الدم، عدم تربية الحيوانات والطيور داخل البيت وعدم ملامسة الحيوانات.

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List of Abbreviations

ABM	Acute Bacterial Meningitis
BM	Bacterial Meningitis
CNS	Central Nervous System
CDC	Centers for Disease Control and Prevention
Hib	Haemophilus influenzatype b
GDP	Gross Domestic Product
GG	Gaza Governorates
IMD	Invasive Meningococcal Disease
MD	Meningococcal Disease
MFMER	Mayo Foundation for Medical Education and Research
MOH	Ministry of Health
NGOs	Non Governmental Organization
NM	Neisseria meningitides
PCBS	Palestinian Central Bureau of Statistics
PCR	Polymerase Chain Reaction
PCV	Pneumococcal Conjugate Vaccine
PM	Pneumococcal Meningitis
SPSS	Statistical Package for Social Sciences
UNRWA	United Nations Relief and Works Agency for Palestinian Refugees in the Near East
URTI	Upper Respiratory Tract Infection
USA	United States of America
WB	West Bank
WHO	World Health Organization

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Chapter One

1.1 Introduction

Meningitis of all types of infection are important cause of morbidity and mortality in children worldwide (Kijalainen et al., 2008).

Meningitis is an acute inflammation of the protective membranes covering the brain and spinal cord, known collectively as the meninges (Sáez-Llorens and McCracken, 2003). The most common causes of meningitis are viral infections that are usually resolved without treatment, however, bacterial meningitis and septicemia are serious, life threatening illnesses with at least 50 kinds of bacteria can cause meningitis, but the main types are: Meningococcal, Pneumococcal, Haemophilus influenza type b (Hib), Streptococcal, and E. coli(Meningitis Research Foundation Offices, 2017).

Despite increased availability of potent antimicrobials and sophisticated intensive care units, bacterial meningitis (BM) continues to be a significant cause of childhood morbidity and mortality. This is reflected in the fact that in 2015 meningitis occurred in about 8.7 million people worldwide (The Lancet, 2016). This resulted in 379,000 deaths – down from 464,000 deaths in 1990, and with appropriate treatment the risk of death in bacterial meningitis decreased to less than 15% (CDC, 2014).

The risk of meningococcal infection in an individual is dependent on the balance of the virulence of the strain and the host's immune response. Moreover, several personal and environmental risk factors have been associated with the disease in several countries (Baccarini et al., 2013).

In Palestine, the rate of Neisseria meningitis (NM) was 10 per 100,000 in 2011, and after the introduction of Hib vaccine in 2008 and Pneumococcal conjugate vaccine (PCV) in 2012, the rate of NM dropped to 4.9 per 100,000 in 2013 and 3.9 per 100,000 in 2014 (MOH, 2014), and the latest reports from Palestinian Ministry of Health – MOH showed that the rate of meningococcal meningitis was 1.2 per 100,000 in Palestine, with a rate of 2.8 per 100,000 in Gaza governorates (GG) and 0.11 in WB (MOH, 2017).

Meningitis causes heavy burden for families and hospitals and with diagnosis and early treatment, up to 15% patients will die, and without treatment the disease is fatal in about

50% of patients, and those who survive may develop complications including brain damage, hearing loss, and disability in about 10% to 20% of patients (WHO, 2018).

Thus, gaining insight of the causes and consequences of the disease, and vaccination strategies are important to assess the best way to reduce the burden of meningitis in our society. GG is facing hard living conditions with low economic status and high poverty rate, and very few studies were conducted to identify the risk factors of meningitis, therefore this study will highlight the risk factors might be contributing to the development of meningitis of different etiologic pathogens.

1.2 Research problem

Meningitis infections of all types are important causes of morbidity and mortality in children worldwide. According to World Health Organization - WHO (2018) report, every year, bacterial meningitis epidemics affect more than 400 million people living in Africa, over 900,000 cases were reported between 1995 - 2014. Of these cases, 10% resulted in deaths, with another 10 - 20% developing neurological sequelae. In Jordan a review study reported 566 cases of meningitis in 2001 decreased to 465 cases in 2014 (Alzein, 2016). Reports from Ministry of Health (MOH) indicated that the incidence of meningococcal disease per 100,000 was 7.13 in 2005, increased to 9.9 in 2008, 9.5 in 2011, and 6.5 in 2013, furthermore, meningitis caused by other types of bacteria was 14.8 in 2005, 6.8 in 2008, 21.6 in 2011, and 5.4 in 2013, also, nonspecific meningitis was 49.6 in 2005, 13.3 in 2008, 50.3 in 2011, and 109.1 in 2013 (MOH, 2011, 2013). These numbers reflect a serious problem and raise the need to identify the causes and predisposing factors of different types of meningitis and establishing appropriate strategy to increase people awareness about the risk factors and take actions to control the incidence of meningitis in GG.

1.3 Significance of the study

Meningitis is highly contagious disease that affects children of all age groups. It is a serious health problem with high morbidity and mortality rate.Meningitis affects more than 2.8 million people globally each year, nearly 320,000 died from meningitis in 2016, and globally, bacterial meningitis leaves one in five with an impairment caused by the disease such as brain injury, and collectively, meningitis and neonatal sepsis are the second biggest infectious killers of children aged under five globally (Meningitis Research Foundation, 2018). Addressing risk factors that contribute to the development of meningitis is essential because many of these factors are modifiable and their risk could be alleviated.

1.4 General objective

The general objective of the study is to identify the risk factors of meningitis among children in Gaza governoratesin order to properly determine the causes and decrease the rate of meningitis infections.

1.5 Specific objectives

- To identify the risk factors of meningitis among children in Gaza governorates.
- To recognize the main risk factors of meningitis among children related to sociodemographic variables.
- To identify the risk factors of meningitis among children related to health history.
- To identify the risk factors of meningitis among children related to health behaviors.
- To suggest recommendations to control the risk factors of meningitis.

1.6 Research questions

- What are the main risk factors of meningitis among children in Gaza governorates?
- Are there a relationship between risk factors of meningitis and sociodemographic variables (place of residency, mothers' level of education, family income, family size) among children in Gaza governorates?
- Are there a relationship between risk factors of meningitis and health history of children (infections, anemia, brain surgery / craniotomy, family members history of meningitis) among children in Gaza governorates?
- Are there a relationship between risk factors of meningitis and health behaviors (hygiene, passive smoking, take medication (NSAID), feeding practices) among children in Gaza governorates?

1.7 Context of the study

1.7.1 Socio-demographic context

Palestine lies within an area of 27,000 Km^2, expanding from Ras Al-Nakoura in the north to Rafah in the south. Due to Israeli occupation, Palestinian territory is divided into three areas separated geographically; the WB 5.655 Km^2, GG 365 Km^2 and east Jerusalem. The total population of Palestinians in WB and GG was 4,952million (3,008 in WB and 1,943 in GG) with male to female ration 103.4. The population density (capita/km^2) is 778 in Palestine (506 in WB and 4,986 in GG) (Palestinian Central Bureau of Statistics - PCBS, 2017).

1.7.2 Economic context

The Palestinian economy is under high pressure to create decent and productive jobs, reduce poverty and provide economic security on an equal basis for all social groups in a rapidly growing and urbanizing population. Economic status in the Palestinian territories is very low. Gross Domestic Product (GDP) is estimated about 9.3%, and the workforce participation 43.6, unemployment is very high and reached a rate of 26.9% for males (15.5% in WB and 34.4% in GG) and for females unemployment rate is 44.7% (29.8% in WB and 65.2% in GG) (PCBS, 2017). Due to blockade of the strip, a significant increase in poverty rates occurred in GG from 38.8% in 2011 to 53% by the end of 2017 (United Nations Office for the Coordination of Humanitarian Affairs - OCHA, 2018).

1.7.3 Health care system

ThePalestinianhealthsystemisacomplexwebofgovernmental,non-governmental,UN, andprivatesectorhealthinstitutionsprovidinghealthservicestoapopulationlivinginthe WBandGS.ThefourmajorgroupsofhealthprovidersaretheMOH,PalestinianNGOs,UnitedNationsReliefandWorksAgencyforPalestinianRefugees in the Near East (UNRWA),andtheprivatesector.The total number of hospitals in Palestine was 81 hospitals, 51 of them in WB including east Jerusalem. The total number of hospital beds in Palestine was 6146 beds with rate of 784 populations per bed (784 in GG and 783 in WB). The number of hospitals in MOH is 27 hospitals with a capacity of 3325 beds which equals 54.1% of total beds in Palestine, of these hospital, there are 14 hospitals in WB with a capacity of 1661 beds while there are 13 hospitals in GG with a capacity of 1664 beds. The number of beds allocated to admit children is 19.3% of the total number of beds in MOH hospitals (260 beds in WB and 381 beds in GG). The number of physicians working in different centers and units of MOH is 2529 physicians, with 5.3 physicians per 10,000 population of Palestine; 4.1 physician per 10,000 populations in WB and 7.0 physician per 10,000 populations in GG, and the number of nurses and midwives working in MOH is 4142 nurses and midwives, of which, 2715 (65.5%) in WB and 1427 (34.5%) in GG(MOH, 2017).

1.7.4 Palestinian children

The Palestinian population is characterized by high percentage of young age as the percentage of people 0 - 14 years is 38.9% (36.6% in WB and 42.6% in GG), and those aged between 15 – 29 years accounted for 29.7% (29.9% in WB and 29.5% in GG) (PCBS, 2017). The number of children under the age of 18 is 2,115,370 children in Palestine according to the results of Population, Housing and Establishments Census 2017, of which 1,083,720 males and 1,031,650 females. The percentage of children in Palestine is 45.3% of the population (43.4% in WB and 48.0% in GG). Data for the scholastic year 2017/2018 showed that the number of school students in Palestine reached about 1.254 million students, of which 1.107 million were children students in the basic stage (50.4% males versus 49.6% females), and the number of children enrolled in kindergartens in Palestine reached about 146.8 thousand children (51.1% males and 48.9% females). In addition, 10.8% of women aged 20-24 were married in childhood under the age of 18 years (8.5% in WB and 13.8% in GG) (PCBS, 2018).

Concerning children's health-related statistics, 0.9% of the children have at least one form of disability (0.7% in WB and 1.2% in GG), 1.1% of male children compared to 0.8% for females. The main causes of disability among children included congenital or genetic causes ranked first by 45.5% (43.5% males and 48.3% females), followed by causes related to pregnancy and childbirth 23.3% (22.8% males and 24.1% females), then 21.1% for pathological causes (22.2% males and 19.6% females). In addition, 25.3% of the children suffer from communication disability followed by mobility disability and use of hands 25.1%, then remembering and Concentration 19.7% and the lowest percentage goes for hearing disability by 13.2% for the year 2017 (PCBS, 2018).

Concerning education, enrollment of children in basic education (6 – 15 years) in GG reached 94.3% for male children and 95.9% for female children. there are 443,425 children enrolled in basic education in GG (223,928 males and 219,497 females), and classroom density was 36.9 (37.1 in government schools and 39.0 in UNRWA schools), and rate of student per teacher was 24.8 (21.9 in government schools and 30.4 in UNRWA schools) (PCBS, 2017).

1.8 Definition of terms

Meningitis

The researcher defines meningitis operationally as " primarily diagnosed as meningitis by a pediatrician".

Risk factor

The researcher defines risk factors operationally as "any factors that predispose the individual to a risk of acquiring meningitis disease including age, economic status of family, level of education of mother, place of residency, and family size".

Child

The researcher defines a child operationally as "any live person, aged between one month and 12 years, and admitted to the medical pediatric department with primary diagnosis of meningitis".

1.9 Lay out of the study

This study consists mainly of five chapters: introduction, conceptual framework and literature review, methodology, results and discussion, conclusion and recommendations.

The first chapter browsed general introduction to the study, where a brief background regarding the subject of the study was provided. The researcher illustrated the research problem, justification for conducting the study, goal and objectives of the study, questions of the study, definition of terms and context of the study.

The second chapter included two parts: the first part is conceptual framework where the researcher provided a schematic diagram of the conceptual framework of the study. The second part is the literature review related to the study topic and variables. In-depth detailed theoretical inquiry including previous studies were presented.

The third chapter described methodology including study design, population, sample, instrument, validation of study instrument, statistical analysis, ethical considerations, and limitations of the study.

In the fourth chapter, the study results and discussion were presented. The researcher treated the results in form of tables and figures that make it easy for the reader to understand. The results were discussed and compared with available published previous studies that related to the topic of this study and its objectives.

Finally, in the fifth chapter, the researcher presented conclusion and recommendations in the light of the study results.

Chapter Two

Conceptual framework and literature review

2.1 Conceptual framework

The conceptual framework was designed by the researcher based on review of available literature. Conceptual framework serves as the map that guides the researcher in the process of conducting the study.

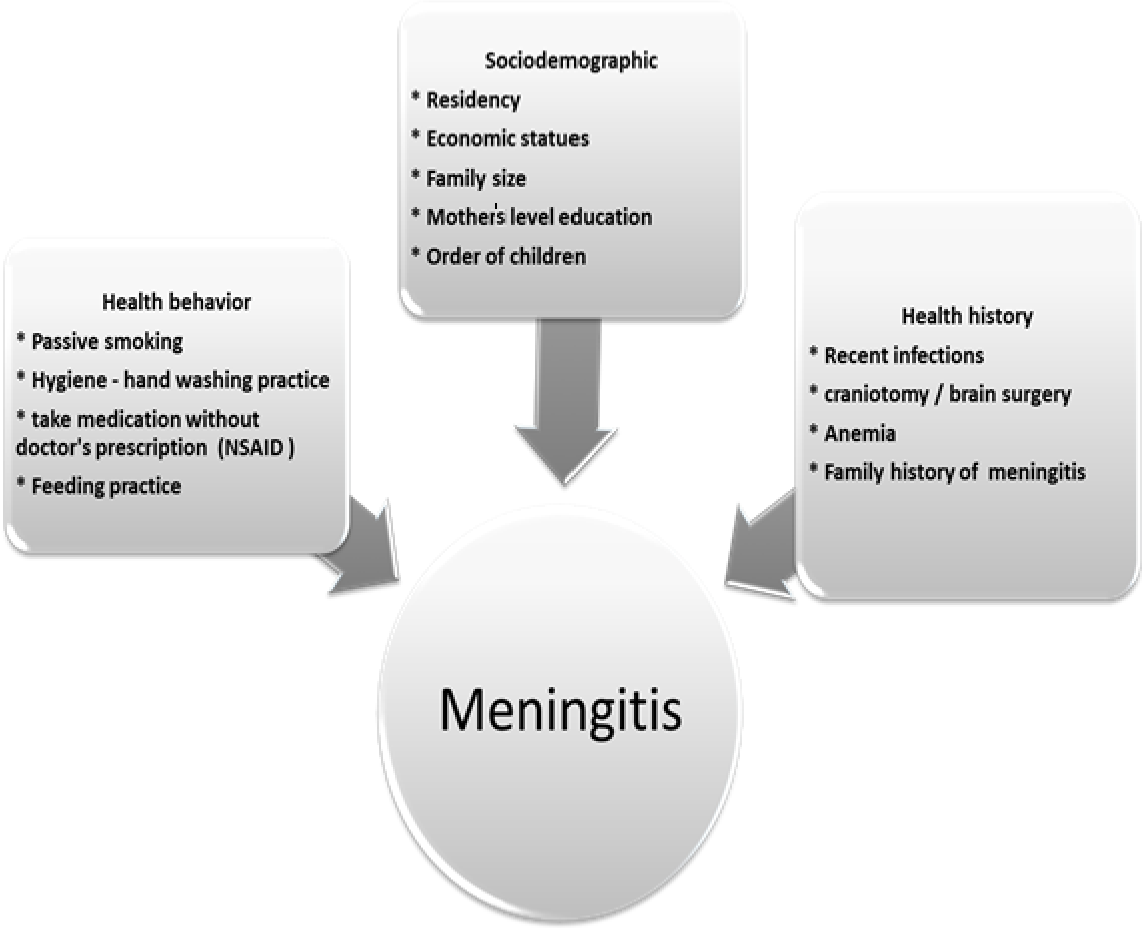


Figure (2.1): Diagram of conceptual framework (self-developed model)

The diagram includes three main domains including, socio-demographic, health history and health behavior.

Socio-demographic domain; includes place of residency; it is suggested that those who live in crowded areas and in small houses are more prone to get infectious diseases.

Economic status; the family economic status play a major role in health and disease, as poor families with low income are unable to secure healthy food for their children which will decrease their immunity and increase the chance for acquiring disease.

Family size and order of child; it is suggested that larger families will face difficulties in maintaining healthy conditions for their children and in turn increase the chance of being vulnerable to infectious disease.

Mothers' level of education; the mother is the main carer of children, and if the mother is educated, she will emphasize healthy practices and hygiene of her children and protect them from many health problems.

Health history domain; includes recent infections; many study reports indicated that recent infections especially respiratory tract infections increase the risk of developing meningitis.

Craniotomy or brain surgery; having a history of craniotomy for any health problem increase the risk of developing meningeal disease.

Anemia; it is suggested that anemia is correlated with malnutrition, and malnutrition will lead to low immunity and increase vulnerability to disease.

Family history of meningitis; presence of meningitis in a family member will increase the risk of transmission of the disease to other family members because meningitis is usually highly contagious.

Health behaviors domain; includes passive smoking; which may affect the respiratory system and increase the chance of developing meningitis.

Hygiene; practicing of hygienic behaviors as hand washing will eliminate the majority of bacteria on hands and act as a protective factor from disease.

Taking medication without prescription like NSAIDs is suggested to cause health problems including renal disease and may affect the meninges.

Feeding practices during childhood is very important. Adequate breast feeding is vital for immunity and well-being of the growing child, while bottle feeding is considered as a source of disease development.

2.2 Literature Review

2.2.1 Background

Meningitis is the inflammation of the membranes surrounding the brain and spinal cord. Meningococcal meningitis (MM) is observed worldwide but the highest burden of the disease is in the meningitis belt of sub-Saharan Africa, stretching from Senegal in the west to Ethiopia in the east, with around 30,000 cases are still reported each year from that area (WHO, 2018).

Over 340,000 occurrences and more than 53,000 casualties were accounted within 1951-1960 from this region of the globe when the total number was just 35 million. On the other hand, epidemics of meningitis are a global problem and can touch any area in the world in spite of the climate. In the 1960s, the disease was seen as a very severe health risk in some of the tropical countries but not a severe health risk in North American and countries in Europe, but this conception changed in the period within 1970s(Umaru et al., 2013). Major epidemics arises very rapidly, and peaks within some weeks, and it is due to the pattern of the transmission of the disease which is from one person to another person through the droplets of respiratory or the secretions from the throat of the carriers, and frequency rates usually remain high for 1 - 2 years after there was an epidemic. The epidemiology of meningitis is always changing, it should be noted that places where the meningitis is endemic are also vulnerable to regular epidemics. When there is an attack, rates reach up to 1,000 per 100,000 (Umaru et al., 2013).

Early treatment of bacterial meningitis (BM) can prevent serious complications such as hearing loss, memory difficulty, learning disabilities, brain damage, seizures and death (Levy et al., 2014a; Grenon et al., 2014).Meningitis can be life-threatening and the condition is classified as a medical emergency. Meningitis usually results from a viral, bacterial or less commonly, fungal infection (Martin et al., 2014).

Meningitis is one of the most significant infections in children, and despite the availability of newer antibiotics and preventive strategies, it remains an important cause of morbidity and mortality in developing countries (John et al., 2007). Usually, meningitis is a complication of a primary bacteremia with a peak incidence in children between birth and 2 years of age, and the incidence of meningitis during the first year of life is 20 times higher than in older children and adults (Ghuneim et al., 2016).

2.2.2 Types of meningitis

A variety of infectious agents can cause meningitis, including bacteria, viruses, fungi, and mycobacteria, and may also be a manifestation of noninfectious diseases.

2.2.2.1 Viral meningitis

Viral meningitis is the most common type of meningitis, and can occur at any age but is most common in young children. A study carried out in Finland aimed to determine the annual incidence of presumed viral meningitis. The target group included 12000 children, and the resultsindicated that the annual incidence of viral meningitis was 219 per 100 000 in infants under 1 year and 27.8 per 100 000 overall in children under 14 (Logan and MacMahon, 2008).It is often less severe than bacterial meningitis, and most people get better on their own without treatment. However, children younger than one month old and people with weakened immune systems are more likely to have severe illness from viral meningitis.Non-polio enteroviruses are the most common cause of viral meningitis, especially from late spring to fall when these viruses spread most often. However, only a small number of people who get infected with enteroviruses will actually develop meningitis (CDC, 2016). Other viruses that may cause meningitis include polioviruses, mumps (paramyxovirus), and herpes simplex virus (Lucile Packard Children's Hospital, Stanford, 2018).

The usual initial approach to viral diagnosis is to test the cerebrospinal fluidfor enteroviruses, herpes simplex virus, and varicella zoster virus by using polymerase chain reaction technology, estimated to be threefold to 1000-fold more sensitive than routine viral culture (Logan and MacMahon, 2008).

2.2.2.2 Bacterial meningitis (BM)

BM is aggressive, develops quickly and can lead to permanent disability or death in a matter of hours. If untreated,it is fatal in approximately 50% of cases and accounts for around 170,000 deaths around the world each year, and most cases of bacterial meningitis are caused by meningococcus , pneumococcus and Hib.BM is a serious illness worldwide, caused by different types of bacteria including Neisseria meningitides (NM), Hib, Streptococcus pneumonia, and others(MOH, 2014).

Invasive meningococcal disease (IMD) is a contagious bacterial disease caused by a meningococcus NM, a Gram-negative bacterium that is classified into 13 capsular groups according to its capsular polysaccharides, and six of these (A, B, C, Y, X and W), are of clinical significance as they cause invasive infections. In Europe, groups B and C are mainly responsible for IMD (CDC, 2016). In the USA, groups B, C and Y cause a high proportion of IMD (Harrison, 2010), while in Africa group A is predominant and groups W, X and C are also endemic (WHO, 2016).

Meningococcal meningitis is a serious infection of the meninges that can cause severe brain damage and other sequelae. Meningococcal infections are transmitted between people through respiratory droplets or secretions. NM inhabits the mucosal membrane of the nose and throat (WHO, 2016). Meningitis caused by NM is considered as life threatening illnesses and involve many organs causing meningitis and septicemia. These types should always be viewed as a medical emergency. These diseases remain a priority concern because of the fatality they cause.Antoniuk et al., (2011) reported that among bacterial meningitis 56.8% caused byNM and38.6% caused by Streptococcus pneumonia.Meningitis and septicemia are the two main clinical forms of IMD, and the onset of the symptoms is sudden and death can follow within hours (Vasilopoulou et al., 2011; Tan et al., 2015).

Table (2.1): Most common bacterial pathogens according to age

Age	Bacterial pathogens
0 – 1 month	*GBS (Streptococcus agalactiae - E. coli - Listeria monocytogenes.
1 – 3 months	GBS – E coli – L monocytogenes – Streptococcus pneumonia – Neisseria meningitidis.
3 months – 3 years	Streptococcus pneumonia - Neisseria meningitidis – GBS – E coli - L monocytogenes.
3 – 10 years	Streptococcus pneumonia - Neisseria meningitidis.
10 – 19 years	Neisseria meningitidis.

Source: Pick et al., (2016).

*GBS= group B streptococcus

2.2.2.3 Fungal meningitis

Fungal meningitis is relatively uncommon and causes chronic meningitis (Grenon et al., 2014). Cryptococcal meningitis is a common fungal form of the disease which affects people with immune deficiencies such as AIDS or people with malignancy (Perfect et al., 2010; Kauffman et al., 2013).Other causes of fungal meningitis include Candida - C. albicans, Coccidioides, Histoplasma, Blastomyces, and Aspergillus (CDC, 2016).

Fungal meningitis is treated with long courses of high dose antifungal medications, usually given through an IV and the length of treatment depends on how strong the immune system is and the type of fungus that caused the infection. For people with weak immune systems, like those with AIDS, diabetes, or cancer, treatment is often longer (CDC, 2016).

Table (2.2): Immunization schedule for Palestine

Age	Vaccine against	Vaccine
Birth	Tuberculosis, hepatitis B	BCG, Hep B
1 month	Poliomyelitis	IPV
2 months	Poliomyelitis, diphtheria,pertussis, tetanus, Haemophilus influenza type B infection, hepatitis B, pneumococcal disease	(IPV) OPV1, DTP+Hib+HepB1, Pneumovax1
4 months	Polio, diphtheria, pertussis, tetanus, Hib infection, Hep B, pneumococcal disease	OPV2, DTP + Hib + Hep B2, Pneumovax2
6 months	Polio, diphtheria, pertussis, tetanus, Hib infection, Hep B	OPV3, DTP + Hib + Hep B3
12 months	Pneumococcal disease, measles, mumps, rubella	Pneumovax3, MMR1
18 months	Polio, measles, mumps, rubella, diphtheria, pertussis, tetanus	OPV4, MMR2, DTP
6 years	Polio, diphtheria, tetanus	OPV5DT
15 years	Tetanus, diphtheria	dT

Source: The Palestinian Institute of Public Health 2012.

2.2.3 Epidemiology of meningitis

The global incidence of bacterial meningitis is difficult to determine. Worldwide, the lack of laboratory capacity in certain regions and underreporting lead to a significant variability in incidence (Luksic et al., 2013). According to Global, regional, and national incidence, prevalence, and years lived with disability for 310 diseases and injuries, 1990-2015 report (2016a), meningitis occurred in about 8.7 million people worldwide.This resulted in 379,000 deaths – down from 464,000 deaths in 1990 (Global, regional, and national life expectancy, all-cause mortality, and cause-specific mortality for 249 causes of death, 1980-2015,2016b), and with appropriate treatment the risk of death in bacterial meningitis is less than 15% (CDC, 2014). Outbreaks of bacterial meningitis occur between December and June each year in an area of sub-Saharan Africa known as the meningitis belt, and smaller outbreaks may also occur in other areas of the world (WHO, 2015).

The incidence has been reported to be 5 to 10 cases per 100,000 population in high-income countries; however, the incidence also varies with age (Heckenberg et al., 2014). Population-based surveillance reported 80.69 cases per 100,000 population in patients younger than 2 months of age (Kaplan, 2016). Incidence of meningitis may vary from place to place and from country to country due to population susceptibility, introduction of new strains and different environmental, sociodemographic, and immunological factors. Understanding the relationship between these factors and the disease is the key for identification of high risk groups and thus take specific strategies to prevent its occurrence (Joardar et al., 2012).

IMD caused by NM is a leading cause of meningitis and sepsis worldwide, thus, monitoring the epidemiology of IMD is an important public health measure.In Austria, IMD isolates from all over Austria were collected at the National Reference Centre for Meningococci, where the microorganism is characterized by serological and molecular methods, as well as by antimicrobial susceptibility testing. These laboratory-based surveillance data from 1995 to 2010 were analyzed by time, place and person, and the results indicated that incidence of IMD ranged between 0.73 and 1.41/100,000 personswith a decreasing trend in Serogroup B IMD incidence,yielding an annual average percentage change(-2.1% and an increasing trend in Serogroup C IMD incidence +4.3%) (Steindl et al., 2011). Moreover, Whittaker et al., (2017) reported that the overall notification rate of meningitis in EU countries was 0.9/100 000 population in 2004, and decreased by 6.6% in

2014. In Australia, the incidence of meningococcal serogroup B (MenB) disease reported to be 1.52 cases per 100 000 population in 2001 decreased to 0.47 per 100 000 in 2015 (Archer et al., 2017).

In USA, an overall incidence of 2.74 per 100,000 infants, and serogroup B was responsible for 64%, serogroup C for 12%, and serogroup Y for 16% of infant cases (MacNeil et al., 2015).Another study conducted in Japan analyzed the epidemiological and clinical data for 2013-2015, and also investigated the risk factors for BM. The study included 407 patients, and the results revealed that the total number of patients hospitalized with bacterial meningitis per 1000 admissions decreased from 1.19 in 2009-2010 to 0.37 in 2013-2015 (Shinjoh et al., 2017).

It is obvious that due to the introduction of vaccines incidence of meningitis decreased considerably. A study carried out in France aimed to analyze the impact of pneumococcal conjugate vaccine (PCV7 and PCV13) on pneumococcal meningitis (PM). The study included 227 pediatric wardsthroughout France with a sample of 4808 BM cases between 2001 to 2012. The results showed that 1406 (29.2%) PM were reported. After pneumococcal conjugate vaccine (PCV13) implementation, from 2009 to 2012, the number of cases significantly decreased by 27.4% (Levy et al., 2014b). Another study conducted in France aimed to understand the benefits of PCV7 followed by PCV13 among a large cohort of pediatric patients with PM from 2001 to 2014.The study included 1582 cases of PM, and the results indicated that after PCV13 implementation, PM cases decreased by 44.0% from 2009 to 2014 (Cohen et al., 2016).

In Europe, bacterial meningitis affects 35000 person each year and has a mortality rate of about 20% (Brouwer and van de Beek, 2012).

In Canada, bacterial meningitis was documented in 11% of 970 children presenting with meningitis, and the most common isolated organisms were: Streptococcus pneumonia (54%), group B streptococci (13%), and Neisseria meningitides (11%), and the mean age was 3.5 ± 2.2 year (Husain et al., 2006). In Athens, Greece, the estimated mean annual incidence rate was 16.9/100,000 for bacterial meningitis, 8.9/100,000 for *Neisseria meningitides*, 1.3/100,000 for *Streptococcus pneumonia*, 2.5/100,000 for *Hemophilus influenza* type b (Hib) before vaccination and 0.4/100,000 for Hib after vaccination (Theodoridou et al., 2007).

In Turkey, meningococcal disease (MD) largely affects those ≤18 years old, with estimated incidences (in 2005 - 2006) of bacterial meningitis at 3.5 per 100,000 (56.5% *N. meningitidis*), meningococcal meningitis at 2.0 per 100,000, and MD at 3.5 - 4 per 100,000 (Ceyhan et al., 2008). From 1985 to 2006, the reported incidence ranged from 1.01 to 5.5 cases per 100,000, indicating an intermediate level of endemic disease (Kurugol, 2006). In 2005–2006, MenW (42.7% of all bacterial meningitis) and MenB (31.1%) were the most prevalent capsular groups in children, while in 2009–2010, the prevalence of MenA had increased (36.6%; MenW: 56.1%; MenB: 7.3%) (Ceyhan et al., 2008). By 2011–2012, MenW was the most prevalent capsular group (56.5% vs. 6.5% for MenB and 6.5% for MenA) (Ceyhan et al., 2014). Prevalence of MenB increased in 2013–2014 (32.9% vs. 42.4% for MenW), but decreased in 2015 relative to MenW (15.8% vs. 42.1%, respectively) (Ceyhan et al., 2016).

In Tunisia, there is no national surveillance network currently operating, and national data generally underestimate the actual burden of MD. Overall reporting of MD reflected that 85% of cases are in children <5 years old and 38% in infants <1 year old. MenB is by far the most prevalent serogroup (80%), and case fatality ratios are around 18% (Borrow et al., 2017).

In Morocco, MD is endemic with sporadic emergence of micro-outbreaks. The incidence rate is 2 - 3.6 per 100, and the case fatality ratio is 7 - 13%, and prevalence was highest in those aged 1 - 4 years (Razki et al., 2016).

In Algeria, disease is most frequent in infants <2 years old and the overall incidence reported in 2012 was 0.09 per 100,000 individuals (0.48 per 100,000 in children <5 years old) (Sante, 2012).

In Palestine, the rate of viral meningitis was 23.1/100,000 population (10.1 in WB and 43.5 in GG), and for bacterial (meningococcal) meningitis the rate was 1.3/100,000 (0.1 in WB and 3.1 in GG). In GG these diseases are endemic with seasonal and governorate variations. The yearly incidence of NM diseases in years 2004-2011 fluctuated between 6.8 to 10 per 100,000 population. In the years 2012-2014, the incidence rate registered a continuous decrease compared to the previous years. In the year 2014, a total of 68 cases were reported of NM diseases with an incidence of 3.9 per 100,000 population while in the year 2013, a total of 84 cases were reported with an incidence of 4.9 per 100,000 population (MOH, 2014). Latest reports from MOH indicated that the incidence rate (IR) of meningococcal meningitis was 1.2 / 100,000 population in Palestine (2.8 in GG and 0.11 in WB), IR of Hemophilus influenza meningitis in Palestine 0.05 / 100,000 population in GG and 0.04 / 100,000 population in WB, other bacterial meningitis 4.3 / 100,000 population in Palestine (5.7 in GG and 3.3 in WB), and viral meningitis 19.2 / 100,000 population in Palestine (36.4 in GG and 7.2 in WB) (MOH, 2017).

2.2.4 Burden of meningitis

Meningitis is a great burden for patients, families, and medical staff. Even though epidemiology has changed a lot after immunization and infection prevention strategies, bacterial meningitis continues to be associated with high mortality and morbidity especially in those still could not be vaccinated (Agrawal and Nadel, 2011). IMD represents a public health problem and a leading cause of morbidity and mortality worldwide. IMD can occur as an endemic disease with sporadic cases or epidemics with outbreaks, and death occurs in 6-10% of cases and sequelae in 4.3-11.2% of cases (Bosis et al., 2015). IDM has a high fatality rate and many survivors develop permanent sequelae **(**Tan et al., 2015). Bacterial meningitis can cause serious complications such as hearing loss, memory difficulties, learning disabilities, brain damage, seizures, and death (Levy et al., 2014a; Grenon et al., 2014).

Aretrospective studyevaluated children with acute bacterial meningitis (between 1 month and 14 years of age) admitted between 2003 and 2006in Brazil reported that 38.6% of patients bacterial meningitis had acute neurological complications, and seizure was the most frequent (31.8%) complication (Antoniuk et al., 2011).

A study carried out by Hénaff et al., (2017) aimed to assess the anatomical and immunologic risk factors in children >5 years old with pneumococcal meningitis between 2001 and 2013. The study included 316 patients with pneumococcal meningitis, and the resultsshowed that the mortality rate was 9.5%, and 23.1% of cases presented complications such as abscess, coma, hemodynamic failure, thrombophlebitis cerebral or deafness. A prospective surveillance study for ABM in children aged 0-59 months admitted to 3 referral hospitals in Guatemala City from 2000 to 2007included 809 children with ABM reported that 27.3% of patients survived with major morbidity and 23.7% died (Olson et al., 2015).Another retrospective cohort study among 151 persons aged 15 years and older diagnosed with IMD in New York City during 2008-2016 identified through communicable disease surveillance found that female patients had higher fatality rate compared to male patients (37% for females vs. 19% for males), and the relative risk of death for females with meningitis was 13.7 (Bloch et al., 2018).A record-based observational study was conducted in Medical College & Hospital, Kolkata, India to identify the socio-demographic profiles, etiological types and nutritional status of the meningitis cases admitted in the Pediatric Medicine department and to find out the case fatality rates and seasonal variations in different etiological types of the disease. A total of 326 meningitis cases in the age group below twelve years comprised the study population, and the results showed that more than 27% of the cases were infants and about 44% were below three years of age. The majority of the cases (60.43%) were male children, and 74.23% live in rural areas. Moreover, 75% of the cases were tuberculous and 34.66% were pyogenic by etiological type. Among those who survived (224) the overall prevalence of undernutrition was 66.52%. The overall case fatality rate was 31.29% (Joardar et al., 2012).According to WHO, even when the disease is diagnosed early and adequate treatment is started, 8% to 15% of patients die, often within 24 to 48 hours after the onset of symptoms. If untreated, meningococcal meningitis is fatal in 50% of cases and may result in brain damage, hearing loss or disability in 10% to 20% of survivors (WHO, 2018).

2.2.5 Risk factors for meningitis

Meningitis can affect anyone at any age yet infants, children, adolescents, and young adults are typically at an increased risk of infection. A variety of factors may contribute to the development of all types of meningitis, and these factors could be individual or community based. Most pathogens are specific to certain age groups, immune status, seasonality, living conditions, travel history and overall health of the individual (Ghuneim et al., 2016).

The risk of meningococcal infection is dependent on the balance of the virulence of the strain and the host's immune response, and several environmental risk factors have been associated with the disease(Baccarini et al., 2013). Risk factors for the development of meningococcal disease include deficiencies in the terminal common complement pathway, functional or anatomic asplenia, underlying chronic disease, certain genetic factors such as polymorphisms in the genes for mannose-binding lectin and tumor necrosis factor, antecedent viral infection, household crowding, active and passive smoking, and low socioeconomic status (CDC, 2015).

Several studies found that risk factors for meningitis include crowded living conditions, close contact with an infected person, a history of recent upper respiratory tract infections and low socio-economic status (Stuart et al., 2002; Heyderman et al., 2004; Cohn et al., 2013).A case-control study was carried out among 133 children (44 cases and 89 controls) aged between 0–14 years, who were hospitalized in a children's hospital in Athens. The study aimed to identify environmental or genetic risk factors that are associated with IMD revealed that changes in a child's residency, paternal smoking, upper respiratory tract infection within the previous month and the density of people in the house/100m^2 were independent risk factors associated with IMD (Hadjichristodoulou et al., 2016).

A population-based, case−control study aimed to identify risk factors for meningococcal disease have been carried out in Chile during January 2012−March 2013 included 135 case-patients and 618 controls found thatconditions of social vulnerability, such as low income and overcrowding, as well as familial history of this disease and clinical histories, especially chronic diseases and hospitalization for respiratory conditions, increased the probability of meningococcal diseases (Olea et al., 2017).A review studyaimed to examine the various factors that have influenced the spread of MM in different regions of the world found that the most important factors that influenced the occurrence of meningitis include poor housing conditions, household crowding, education, income level, age, sex, smoking, respiratory tract infection, climate and geographical location, environment, urbanization, and recreational spaces as the cause of the spread of meningococcal meningitis (Umaru et al., 2013). A cross-sectional survey studies all patients with meningitis from 2004 to 2014 in Iran aimed to determine the epidemiology and risk factors of meningitis in Zahedan found that gender was a significant risk factor as 53% were male patients and 47% were female patients (Sharifi-Mood et al., 2015).

Other studies found that risk factors for meningitis include skipping vaccinations, age (most cases of viral meningitis occur in children younger than fiveyears old and bacterial meningitis commonly affects people under 20), living in a community setting such as, children in schools and child care facilities are at increased risk of meningococcal meningitis, and factors that may compromise patients’ immune system including; AIDS, use of immunosuppressant drugs, and removal of the spleen (Grenon et al., 2014; Martin et al., 2014; Perfect et al., 2010).Furthermore, a study carried out in Iraq among children under 5 years old aimed to find out risk factors of meningitis during the period from 2005 to 2007. The study included 336 children, and the results reflected that age, urban residency, crowding, low economic state, bottle feeding, recent upper respiratory tract infection were significant risk factors for developing meningitis, while gender, water supply, maternal education head trauma, family history of meningitis, and animal breeding were insignificant risk factors (Al-Ani, 2009). Moreover, an observational record-based study was conducted in a tertiary care hospital in India. The available records of all the meningitis cases admitted in pediatric medicine department from January 2007 to December 2009 were studied.The study included 326 meningitis and the resultsshowed that 27% of cases and 44% were below three years old. The majority of cases were male children, live in rural areas, and among those who survived 66.52% were undernutrition (Joardar et al., 2012).Another study conducted in United States of America (USA)aimed to describe causes, complication and sequelae of BM in children reported that risk factors of meningitis include preterm birth, low birth weight, galactosemia, urinary tract abnormalities, dermal sinus tract of the spine, asplenia, primary immunodeficiency, sickle cell anemia, CSF leak, recent URTI, lack of breast feeding, penetrating head trauma, travel to an area with endemic meningococcal disease, and lack of immunization (Swanson, 2015), while earlier study carried out in the USA indicated that active and passive smoking, recent respiratory illness, corticosteroid use, new residence, new school, and household crowding were associated with increased risk of meningitis, whereas income, and race were not significant risk factors (Bilukha and Rosenstein, 2005). A hospital-based active surveillance conducted in France from 2001 to 2014, included 1582 cases of PM found that younger age was a risk factor for meningitis and 62.5% of cases were younger than 2years old (Cohen et al., 2016).

There is a growing body of literature to suggest that exposure to passive smoke may play a role in the development of meningitis. A retrospective, case-controlled survey carried out in Australia included parents of 71 children admitted to the Women's and Children's Hospital, North Adelaide, with bacterial meningitis found that children who had meningitis were significantly more likely to have parents who smoked inside the house than children who had not had meningitis (66% vs. 28%) (Iles et al., 2001). A meta-analysis study found that second hand smoking in the home doubled the risk of invasive meningococcal disease with some evidence of an exposure-response gradient. The strongest effect was seen in children under 5 years. Also, maternal smoking significantly increased the risk of invasive meningococcal disease by 3 times during pregnancy and by 2 times after birth (Murray et al., 2012). Recent case-control study carried out in Washington found that having a mother who smokes was the strongest independent risk factor for invasive meningococcal disease in children < 18 years of age (Fischer et al., 1997). Earlier retrospective cohort study carried out in Atlanta, USA assessed the association between maternal cigarette smoking during pregnancy and the risk of invasive meningococcal disease during early childhood found that the crude rate of meningococcal disease was 5 times higher for children whose mothers smoked during pregnancy than for children whose mothers did not smoke and that mother's having fewer than 12 years of education was associated with invasive meningococcal disease (Yusuf et al., 1999). In addition, Al-Ani (2009) reported that passive smoking was a significant risk factor for developing meningitis among children under 5 years old. Furthermore, Kriz et al., (2000) reported that both active and passive smoking in particular have been found to increase the risk of IMD in pediatric populations.Furthermore, a population-and laboratory-based surveillance for NM conducted in USA aimed to identify incidence and risk factors associated with meningococcal disease during 2006 through 2012. The results showed that the overall incidence of meningitis was 2.74 per 100,000 infants, and that 62% of the cases had a smoker in the household (MacNeil et al., 2015).

A population-based case-control study aimed to investigate whether passive cigarette smoke exposure increases the risk of invasive pneumococcal disease in children. The study had been conducted from 1994 to 2004 and included 171 children aged 0 to 12 years with culture-confirmed invasive pneumococcal disease indicated that elevated risk of invasive pneumococcal disease was found in subjects with recent pulmonary diagnoses and recent antibiotic use, while passive cigarette smoke exposure was not associated with invasive pneumococcal disease (Chun et al., 2015).

Behavior is another risk for meningitis.Viral meningitis is typically caused by enterovirus, and is most commonly spread through fecal contamination, thus the risk of infection can be decreased by changing the behavior that led to transmission (CDC, 2009).

In GS a cross-sectional study carried out in two pediatric hospitals; Al Nasser and Al Dora hospitals from January to December 2009. The study aimed to identify epidemiology and risk factors of meningitis. The study included 1853 patients and all cases were subjected to clinical examination as well as CSF bacteriological and serological investigations. The results indicated that the most significant factors associated with developing meningitis were malnutrition, low hemoglobin level, high house crowdness and irritability (Al Jarousha and Al Afifi, 2014).

2.2.6 Clinical manifestations

The most common clinical manifestations of IMD are meningitis and septicemia, although in some cases both clinical pictures are present, and the clinical pattern can differ according to age; in young children, the clinical manifestations may be more insidious and the diagnosis may be more difficult compared to older children or adolescents. Early recognition of children with meningococcal infection is important in order to initiate systemic antibiotic therapy, although vaccination remains the best strategy to control meningococcal disease. Recently, different meningococcal vaccines have been introduced worldwide, resulting in a reduction in the overall burden of the disease (Bosis et al., 2015).Moreover, Sharifi-Mood et al., (2015) found that common clinical symptoms among patients with meningitis included fever and headache (90%), vomiting (69%), confusion (11%), and seizures (9%).

Meningococcal meningitis, caused by NM bacteriahave an average incubation period of four days, but can range between 2 and 10 days. The most common symptoms are a stiff neck, high fever, sensitivity to light, confusion, headaches and vomiting. In addition in infants, bulging fontanels. A less common but even more severe (often fatal) form of meningococcal disease is meningococcal septicemia, which is characterized by a hemorrhagic rash and rapid circulatory collapse (WHO, 2018).

2.2.7 Diagnosis and therapeutic management

Meningitis can be life-threatening and classified as a medical emergency. Meningitis usually results from a viral infection, yet the cause may also be bacterial or less commonly fungal infection (Martin et al., 2014).According to WHO, initial diagnosis of meningococcal meningitis can be made by clinical examination followed by a lumbar puncture showing a purulent spinal fluid. The bacteria can sometimes be seen in microscopic examinations of the spinal fluid, and the diagnosis is supported or confirmed by growing the bacteria from specimens of spinal fluid or blood, by agglutination tests or by polymerase chain reaction (PCR). The identification of the serogroups and susceptibility testing to antibiotics are important to define control measures (WHO, 2018).

Children often exhibit nonspecific symptoms such as irritability and drowsiness, thus to diagnose meningitis accurately, a lumber puncture is needed to diagnose or exclude meningitis. The treatment in acute meningitis consists of promptly administered antibiotics and sometimes antiviral drugs, and corticosteroids can also be used to prevent complications from excessive inflammation (Sharifi-Mood et al., 2015).

Acute bacterial meningitis remains a significant cause of pediatric illness and death in low and middle income countries, thus, early prompt treatment should be commenced to prevent subsequent serious complications (Levy et al., 2014a; Grenon et al., 2014), while viral meningitis may improve without treatment, but bacterial meningitis is very serious and requires prompt antibiotic treatment (Sharifi-Mood et al., 2015).

PM remains a leading cause of vaccine-preventable death worldwide in children <5 years of age. The seven-valent pneumococcal conjugate vaccine (PCV7) was approved in 2001 in Europe and was introduced into the national immunization programs of many European countries from 2006-2008, and in 2009, higher-valent PCVs (PCV10 and PCV13) became available, replacing PCV7 from 2009-2011 (Tin Tin Hatar et al., 2015). According to MOH reports, PCV started to be given on January 2012 (MOH, 2013)..

2.3 Summary

Meningitis is an infection of the meninges that covering the brain and spinal cord and CSF. Most infections are caused by viruses, and less common caused by bacteria, fungi, and protozoa. Meningitis is potentially life-threatening and has high mortality rate if untreated. Delay in treatment potentially predispose the affected individual to serious complications and poor outcome, so, early recognition of signs and symptoms, detection, accurate diagnosis and prompt treatment is crucial for meningitis patients. There is a considerable variation in the incidence rate of meningitis worldwide. The incidence has been reported to be 5 - 10 cases per 100,000 population in high-income countries (Heckenberg et al., 2014). Incidence of meningitis may vary from region to region due to population susceptibility, introduction of new strains and different environmental, sociodemographic, and immunological factors. There is a wide range of risk factors that may contribute to the development of meningitis including younger age, gender, crowded places, family history of meningitis, head trauma and brain surgery, low socioeconomic conditions, indoor smoking and exposure to passive smoking, breeding animals inside the home. It is obvious to say that many of these factors are modifiable to decrease the risk of developing meningitis.

Chapter Three

Methodology

3.1 Study design

The researcher used case-control design in this study. In this type of design, large number of participants could be included in relatively short period of time, in addition to that, this design is suitable to identify the risk factors associated with the occurrence of disease, because it make matching between healthy individuals (controls) with diseased individuals (cases) (Carlos, 2011).

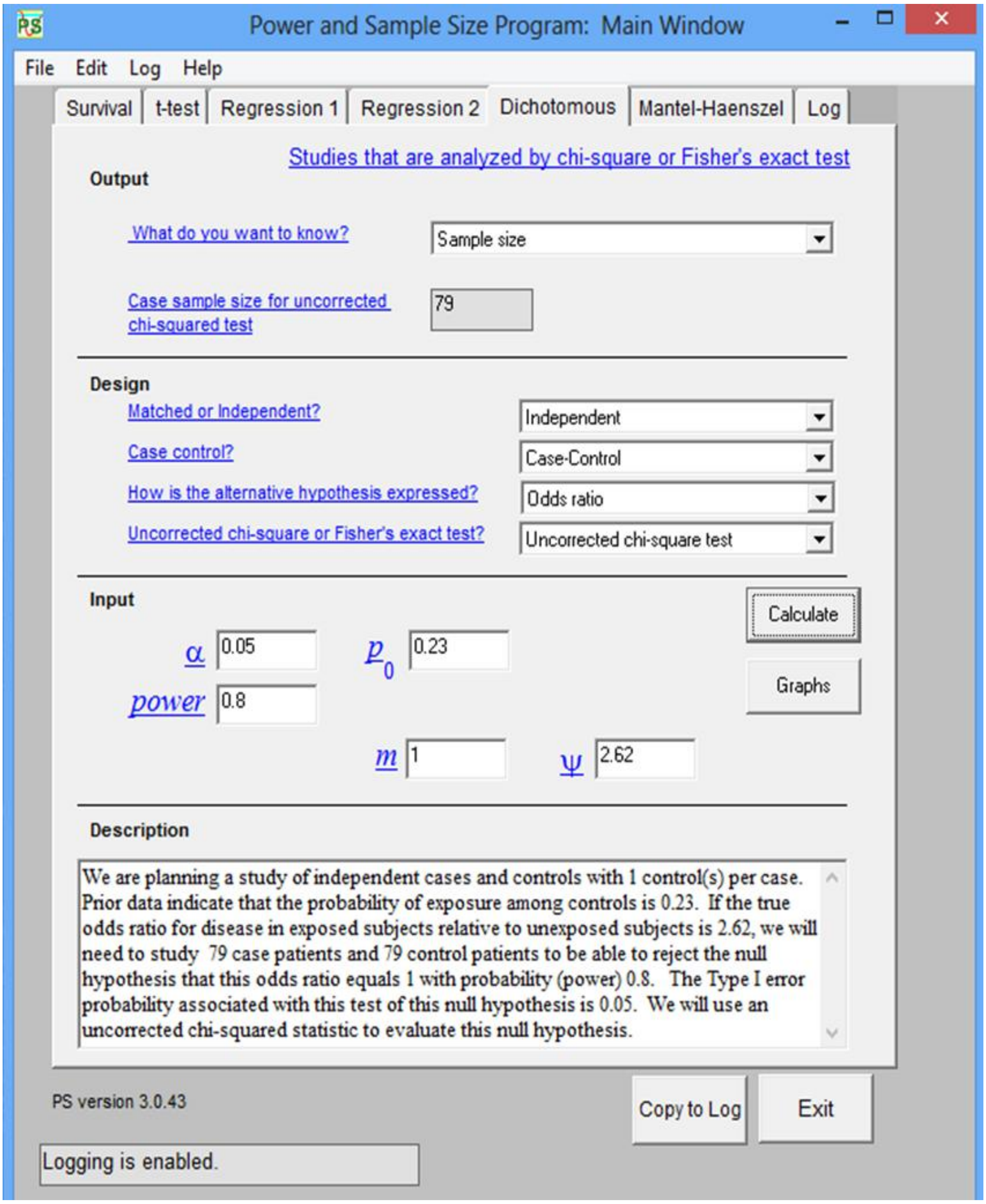
3.2 Study population

The study population consisted of all children with confirmed diagnosis of meningitis who were admitted to pediatric department in Gaza governmental hospitals. The number of children diagnosed with all types of meningitis was 984 in 2015 and 845 in 2016.

3.3 Sample size and sampling method

The researcher used power and sample program for sample size calculation. The mean number of cases for the two years 2015 and 2016 was 914, and the calculated sample size equals 79 patients at 95% confidence interval.

The sample of the study consisted of two groups; (case group) consisted of all children who met inclusion criteria, with confirmed diagnosis of meningitis and admitted to the pediatric medical ward in the main governmental hospitals that offer pediatric health care. Their total number was 87 children. The second group (control group) consisted of 87 children from the out-patient department from the same hospitals who were not diagnosed with meningitis. Matching with age (all children in both groups aged 1 month to 12 years), gender and place of treatment was implemented for the two groups.


Power and Sample Size Program: Main Window
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Studies that are analyzed by chi-square or Fisher's exact test
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79
Design
Matched or Independent?
Independent
Case control?
Case-Control
How is the alternative hypothesis expressed?
Odds ratio
Uncorrected chi-square or Fisher's exact test?
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α
0.05
p0
0.23
power
0.8
m
1
ψ
2.62
Description
We are planning a study of independent cases and controls with 1 control(s) per case. Prior data indicate that the probability of exposure among controls is 0.23. If the true odds ratio for disease in exposed subjects relative to unexposed subjects is 2.62, we will need to study 79 case patients and 79 control patients to be able to reject the null hypothesis that this odds ratio equals 1 with probability (power) 0.8. The Type I error probability associated with this test of this null hypothesis is 0.05. We will use an uncorrected chi-squared statistic to evaluate this null hypothesis.
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Table (3.1): Matching of sample subjects by age, gender and place of treatment

Variable	Case group (N)	Control group (N)
Gender		
Male	47	47
Female	40	40
Total	**87**	**87**
Place of treatment (Hospital)		
Kamal Odwan (North)	20	20
Al Nassr (Gaza)	10	10
Al Dora (Gaza)	13	13
Shohada Al Aqsa (Mid-zone)	15	15
Al Tahreer (Khanyounis)	15	15
European Gaza Hospital (Khanyounis)	14	14
Total	**87**	**87**

3.4 Setting of the study

The study was carried out in the main governmental hospitals that have medical pediatric departments; Kamal Odwan hospital in North Gaza, Al-Nassr Pediatric Hospital in Gaza, Al Dora Pediatric Hospital in Gaza,Shohada Al Aqsa Hospital in mid-zone, European Gaza Hospital in Khanyounis, Al-Tahreer Maternity and Pediatric Hospital in Khanyounis.

3.5 Period of the study

The study was conducted during the period from April 2017 to June 2018, and data collection took place during the period from October to December 2017.

3.6 Eligibility criteria

3.6.1 Inclusion criteria

Case group:

- Any child diagnosed with meningitis by a pediatrician.
- Age between one month to 12 years (according to rules and regulations in MOH).
- Admitted to pediatric department in the assigned hospitals.

Control group:

- Any child free from meningitis.
- Age between one months to 12 years.
- Coming to the out-patient department or primary health care centers for follow-up.
- Any child who had influenza or pneumonia.

3.6.2 Exclusion criteria

- Children aged less than one month and children aged more than 12 years.
- Those who admitted with suspected meningitis but have not confirmed by a physician.

3.7 Instrument of the study

The researcher reviewed previous literature and developed a questionnaire suitable to the study variables. The questionnaire included: (annex 1)

- Sociodemographic data for parents.
- Personal information of the child.
- Past medical history.
- Health behavior.

3.8 Pilot study

Before data collection, the questionnaire was evaluated for validation and clarity of its contents by a group of expertise in the field to ensure that the questionnaire is suitable for the study objectives, and their comments were considered in modifying the questionnaire (annex 4). Then the researcher performed a pilot study on a small sample of 10 questionnaires, and it revealed that the questionnaire was clear, obvious, and no further modifications needed.

3.9 Data Collection

Data were collected by the researcher with help from the mothers of eligible children. Time allocated for each questionnaire between 15 – 20 minutes.

3.10 Data entry and analysis

Collected data were analyzed by using SPSS program version 20. The following process were implemented:

1. Reviewing the questionnaire.
2. Data coding and entry to the program, and data cleaning.
3. Formation of frequency tables, percentage, means, and standard deviation to variables of the study.
4. Cross tabulation by using of chi square test was used to examine relationship between categorical variables.
5. Use of odds ratio (OR) with confidence interval 95% CI was used to assess statistical significance of risk factors.

3.11 Ethical and administrative considerations

Before conducting the study, the researcher obtained approval from Al Quds university. In addition, approval letter was obtained from Helsinki Committee (annex 2) and MOH (annex 3). Furthermore, every mother of the participants children received explanation regarding the study: consent form about the purpose of the study, confidentiality of information, instrument, and right of voluntary participation.

3.12 Limitation of the study

- Frequent, long hours of cutting off electricity.
- Lack of local studies and literature.
- Financial constraints.

Chapter Four

Results and discussion

4.1 Socio-demographic characteristics of study participants

The sample of the study consisted of 174 children divided equally into two groups, (case group) consisted of 87 children who are admitted to pediatric ward in the assigned hospitals with confirmed medical diagnosis of meningitis, and (control group) consisted of 87 children selected from outpatient departments from the same hospitals, their age range between one month to 12 years. Participants' characteristics are illustrated below.

4.1.1 Distribution of participants according to demographic characteristics

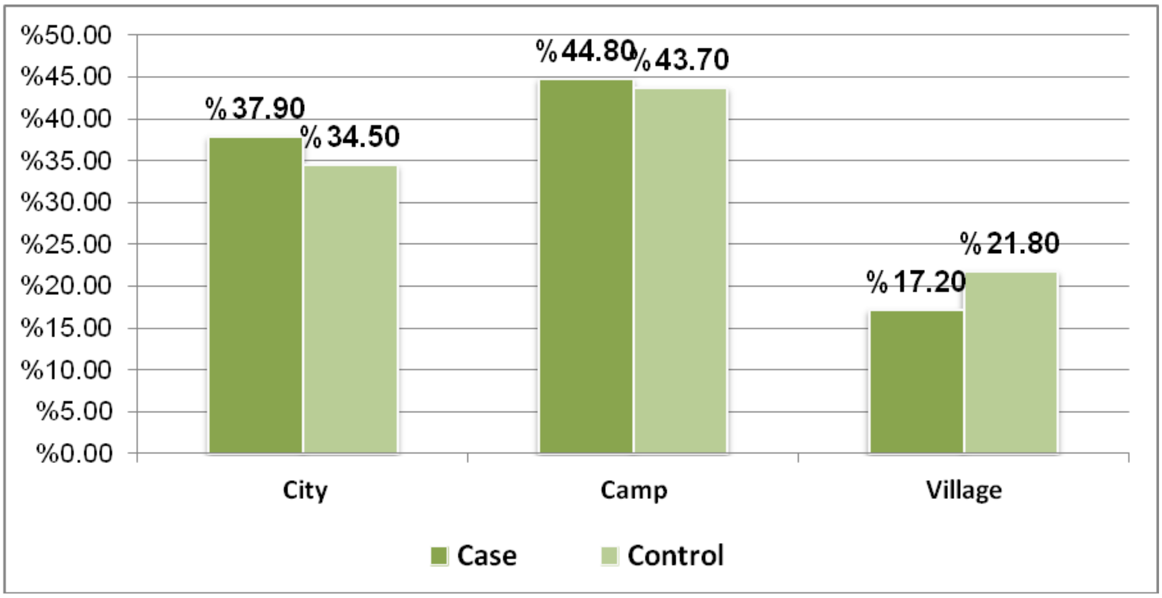

Figure (4.1): Distribution of participants by type of living area

Figure (4.1) showed that 33 (37.9%) of children from the case group and 30 (34.5%) of children from the control group live in cities, 39 (44.8%) of children from the case group and 38 (43.7%) of children from the control group live in camps, and 15 (17.2%) of children from the case group and 19 (21.8%) of children from the control group live in villages, and there were statistically insignificant differences between the two groups in relation to type of living area.

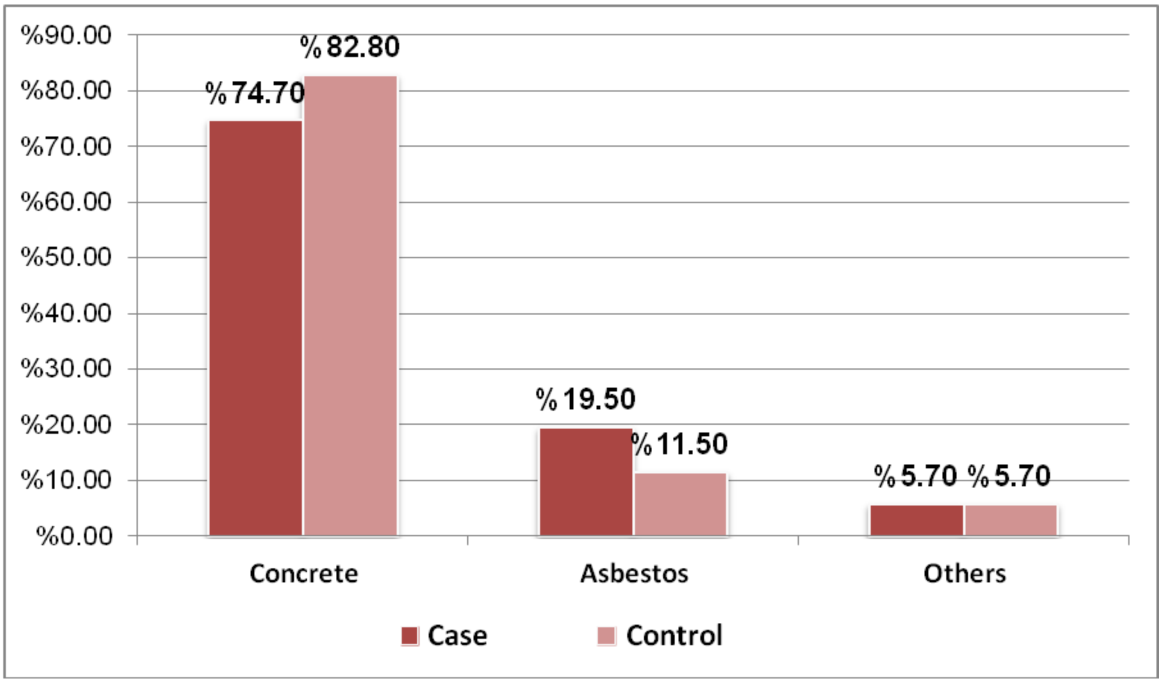

Figure (4.2): Distribution of participants by house construction

Figure 4.2 showed that 65 (74.7%) of children from the case group and 72 (82.8%) of children from the control group live in concrete house, 17 (19.5%) of children from the case group and 10 (11.5%) of children from the control group live in asbestos house, and there were statistically insignificant differences between the two groups in relation to house construction.

Table (4.1): Distribution of participants according to demographic characteristics

Factor	Category	Case N (%)	Control N (%)
Type of housing	Flat	70 (80.5)	62 (71.3)
	Tent	4 (4.6)	6 (6.9)
	Land	13 (14.9)	19 (21.8)
Crowded index (Number of children in the family)	Two and less	38 (43.7)	48 (55.2)
	Three	31 (35.6)	26 (29.9)
	Four and more	18 (20.7)	13 (14.9)

Table 4.1 showed that 70 (80.5%) of children from the case group and 62 (71.3%) of children from the control group live in flats, 4 (4.6%) of children from the case group and 6 (6.9%) of children from the control group live in tents, 13 (14.9%) of children from the case group and 19 (12.8%) of children from the control group live in land house. The results also showed that 38 (43.7%) of children from the case group and 48 (55.2%) of children from the control group live in family with two children and less, 31 (35.6%) of children from the case group and 26 (29.9%) of children from the control group live in family with three children, 18 (20.7%) of children from the case group and 13 (14.9%) of children from the control group live in family with four children and more. Previous studies revealed that living and house environment conditions have a role in developing meningitis. A study conducted in Greece revealed that changes in a child's life setting including relocation or vacation were significant risk factors for IMD (Hadjichristodoulou et al., 2016), and Al-Ani, (2009) found that urban residency was significant risk factors for developing meningitis. Furthermore, Joardar et al., (2012) found that the majority of meningitis cases were living in rural areas, and Bilukha and Rosenstein, (2005) found that household crowding was associated with increased risk of meningitis. Also, Al Jarousha and Al Afifi, (2014) indicated that high house crowdness was significant factor associated with developing meningitis.

4.1.2 Association between meningitis and parents' age, work, education and income

Table (4.2): Association between meningitis and parents age and education

Factor	Case N (%)	Control N (%)	χ2 (df)	Crude OR (95%CI)	*P* value*
Mothers' age					
Less than 30 years	58 (56.3)	45 (51.7)	4.021 (1)	0.536 (0.290 - 0.989)	0.046
30 years and above	29 (33.3)	42 (48.3)			
Fathers' age					
Less than 30 years	48 (55.2)	32 (36.8)	5.923 (1)	0.473 (0.258 – 0.867)	0.016
30 years and above	39 (44.8)	55 (63.2)			
Mothers' education					
University ®	33 (37.9)	35 (40.2)	1.686 (3)	1	
Secondary	41 (47.1)	35 (40.2)		1.242 (0.645,2.393)	0.516
Elementary	12 (13.8)	14 (16.1)		0.909 (0.367, 2.249)	0.837
Not educated	1 (1.1)	3 (3.4)		0.354 (0.035,3.571)	0.378
Fathers' education					
University ®	34 (39.1)	42 (48.8)	2.925 (3)	1	
Secondary	29 (33.3)	27 (31.4)		1.327 (0.664,2.651)	0.423
Elementary	23 (26.4)	15 (17.4)		1.894 (0.858,4.183)	0.114
Not educated	1 (1.1)	2 (2.3)		0.616 (0.059,7.105)	0.699

Table 4.2 showed that (33.3%) of mothers from the case group and 42 (48.3%) of mothers from the control group aged30 years and above, and there were statistically insignificant differences between the two groups in relation to mothers' age. Also, 39 (44.8%) of fathers from the case group and 55 (63.2%) of fathers from the control group aged 30 years and

above, and there were statistically significant differences between the two groups in relation to fathers' age. These results indicated that older aged parents was significant protective factor which means that children whose their parents are 30 years old and above have lower rate of meningitis compared to children of younger age parents.

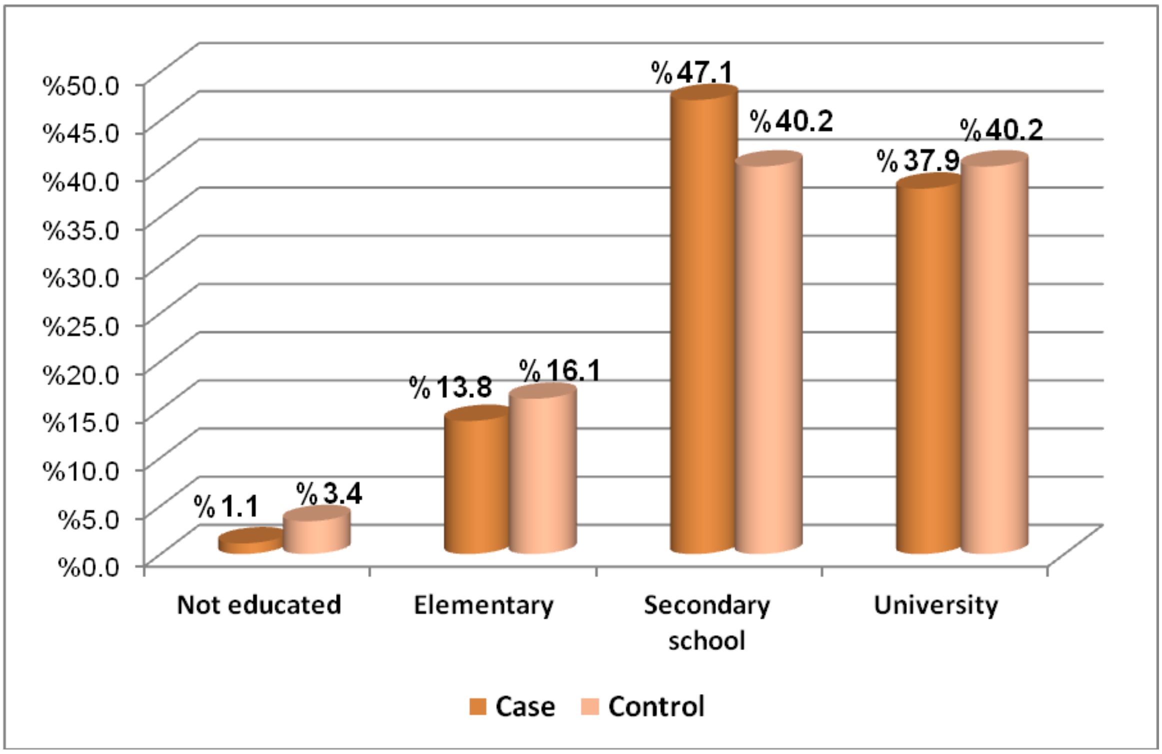

Figure (4.3): Distribution of mothers by level of education

In addition, 33 (37.9%) of mothers from the case group and 35 (40.2%) of mothers from the control group had university education, 41 (47.1%) of mothers from the case group and 35 (40.2%) of mothers from the control group had secondary education, 12 (13.8%) of mothers from the case group and 14 (16.1%) of mothers from the control group had elementary school education, 1 (1.1%) of mothers from the case group and 3 (3.4%) of mothers from the control group were not educated. Also, 34 (39.1%) of fathers from the case group and 42 (48.8%) of fathers from the control group had university education, 29 (33.3%) of fathers from the case group and 27 (31.4%) of fathers from the control group had secondary education, 23 (26.4%) of fathers from the case group and 15 (17.4%) of fathers from the control group had elementary school education, 1 (1.1%) of fathers from the case group and 2 (2.3%) of fathers from the control group were not educated, and there were statistically insignificant differences between the two groups in relation to parents' level of education. Different results obtained by Umaru et al., (2013) which indicated thatlow education was among the most important factors that influenced the occurrence of meningitis, while Al-Ani (2009) found that low maternal education was insignificant risk factor for meningitis.

Table (4.3): Association between meningitis and parents work and income

Factor	Case N (%)	Control N (%)	χ^2 (df)	Crude OR (95%CI)	*p* Value
Mothers' work					
Yes	9 (10.3)	14 (16.3)	1.321 (1)	1.684 (0.688 - 4.131)	0.254
No®	78 (89.7)	72 (83.7)			
Fathers' work					
Yes	63 (72.4)	47 (54.0)	6.327 (1)	0.448 (0.238 - 0.842)	0.013
No®	24 (27.6)	40 (46.0)			
Income					
Under poverty line	73 (91.3)	58 (77.3)	7.787 (1)	0.327 (0.127,0.842)	0.021
Above poverty line®	7 (8.8)	17 (22.7)			

Table 4.3 showed that the majority of mothers in both groups were not working as 9 (10.3%) of mothers from the case group and 14 (16.3%) of mothers from the control group were working, while 78 (89.7%) of mothers from the case group and 72 (83.7%) of mothers from the control group were house keepers, and there were statistically insignificant differences between the two groups in relation to mothers' work. In addition, 63 (72.4%) of fathers from the case group and 47 (54.0%) of fathers from the control group were working, and 24 (27.6%) of fathers from the case group and 40 (46.0%) of fathers from the control group were not working, and there were statistically significant differences between the two groups in relation to fathers' work [OR 0.448,95% CI (0.238-0.842), P= 0.013], which indicated that children whose their fathers were working had lower chance to acquire meningitis, and that father's work was a protective factor for developing meningitis.

The results also showed that 7 (8.8%) of children from the case group and 17 (22.7%) of children from the control group live in families with high income (above poverty line), [OR 0.327, 95% CI (0.127 – 0.842), P= 0.021], which indicated that high income was a significant protective factor for meningitis.

These results agreed with CDC report (2015) which indicated that low socioeconomic status was among risk factors for meningitis. In addition, Stuart et al., (2002); Heyderman et al., (2004); Cohn et al., (2013) found that low socio-economic status was among risk factors of meningitis. Moreover, Olea et al., (2017) reported that conditions of social vulnerability such as low income increased the probability of meningococcal diseases. Also, Umaru et al., (2013) indicated that income level was among the most important factors that influenced the occurrence of meningitis, and Al-Ani (2009) reported that low economic state was significant risk factors for developing meningitis, while Bilukha and Rosenstein, (2005) reported that income was insignificant risk factor for meningitis.

4.1.3 Association between meningitis and type of family

Table (4.4): Association between meningitis and type of family and number of children

Factor	Case N (%)	Control N (%)	χ^2 (df)	Crude OR (95%CI)	*P* value*
Type of family					
Nuclear®	65 (74.7)	78 (89.7)	6.633 (1)	2.933 (1.263 - 6.812)	0.012
Extended	22 (25.3)	9 (10.3)			
Number of children					
One®	31 (35.6)	13 (14.9)	15.430 (3)	1	
Two	36 (41.4)	32 (36.8)		0.472 (0.211 - 1.054)	0.067
Three	17 (19.5)	35 (40.2)		0.204 (0.085 - 0.486)	0.000
Four and more	3 (3.4)	7 (8.0)		0.180 (0.040 - 0.805)	0.025

Table 4.4 showed that the majority of mothers in both groups were living in nuclear family as 65 (74.7%) of mothers from the case group and 78 (89.7%) of mothers from the control group were living in nuclear family, while 22 (25.3%) of mothers from the case group and 9 (10.3%) of mothers from the control group were living in extended family, and there were statistically significant differences between the two groups in relation to type of family in favor of extended family (P= 0.012), which means that those who are

living in extended family have higher rate of meningitis compared to those living in nuclear family, and that living in extended family is considered a risk factor for meningitis. The results also showed that the majority of families in both groups have two to three children, and that families with three children[OR 0.204, CI 95% (0.085 - 0.486), P= 0.000] and families with four children or more [OR 0.180, CI 95% (0.040 - 0.805), P= 0.025] were at lower risk to acquire meningitis. These results reflected that having high number of children was a protective factor for meningitis. This result could be explained in the context that having higher number of children gives the parents more experience in growing their children and increase their knowledge and skills in proper and hygienic practices that decrease the chance of acquiring diseases.

Different resultsobtained by some previous studies including a survey carried out by CDC (2015) which revealed that household crowding was considered a risk factor for meningitis. In addition, Stuart et al., (2002); Heyderman et al., (2004); and Cohn et al., (2013) found that risk factors for meningitis included crowded living conditions, and close contact with an infected person. Moreover, Hadjichristodoulou et al., (2016) found that the density of people in the house was a risk factors associated with IMD, and Olea et al., (2017) reported that overcrowding increased the probability of meningococcal diseases. Also, Umaru et al., (2013) found that poor housing conditions household crowding were among the most important factors that influenced the occurrence of meningitis. Moreover, Al-Ani, (2009) found that crowding was significant risk factors for developing meningitis.

4.2 Association between meningitis and children characteristics

Table (4.5): Association between meningitis and child personal information

Factor	Group		χ^2 (df)	Crude OR (95%CI)	*P* value*
	Case N (%)	Control N (%)			
Child gestational age					
Full term®	70 (81.4)	77 (91.7)	4.066 (2)	1	
Preterm	13 (15.1)	5 (6.0)		2.860 (0.970 - 8.430)	0.057
Post term	3 (3.5)	2 (2.4)		1.650 (0.268 - 10.166)	0.589
Order of the child					
First	23 (26.4)	9 (10.3)	10.161 (5)	2.236 (0.780 - 6.408)	0.134
Second	12 (13.8)	14 (16.1)		0.750 (0.262 - 2.150)	0.592
Third	16 (18.4)	28 (32.2)		0.500 (0.194 - 1.286)	0.150
Fourth	11 (12.6)	10 (11.5)		0.500 (0.194 - 1.286)	0.947
Fifth	9 (10.3)	12 (13.8)		0.963 (0.315 - 2.941)	0.462
Sixth and above®	16 (18.4)	14 (16.1)		1	

Table 4.5 showed that 70 (81.4%) of children from the case group and 77 (91.7%) of children from the control group were full term children, 13 (15.1%) of children from the case group and 5 (6.0%) of children from the control group were preterm children [OR 2.860, 95% CI (0.970 – 8.430), P= 0.057] which indicated that being preterm child is a risk factor to meningitis.

Moreover, the results showed that 23 (26.4%) of children from the case group and 9 (10.3%) of children from the control group were the first child in their family, 12 (13.8%) of children from the case group and 14 (16.1%) of children from the control group were the second child in their family, 16 (18.4%) (P= 0.057) of children from the case group and 28 (32.2%) of children from the control group were the third child in their family, 11 (12.6%) of children from the case group and 10 (11.5%) of children from the control group were the fourth child in their family, 9 (10.3%) of children from the case group and 12 (13.8%) of children from the control group were the fifth child in their family, 16 (18.4%) of children from the case group and 14 (16.1%) of children from the control group were the sixth child and above in their family, and there were statistically insignificant differences between the two groups in relation to their order, which indicated that order of child is not a risk factor to meningitis.

Gestational age has an influence on meningitis, and in this regard Swanson, (2015) reported that preterm birth and low birth weight were significant risk factors for meningitis. in addition, Caserta (2015) reported that neonatal bacterial meningitis occurs in 2/10,000 full-term babies and 2/1,000 low birth weight babies.Furthermore, Gupta et al., (2018) emphasized that neonatal meningitis is associated with prematurity and gestational age.Another study carried out by Lin et al., (2012) indicated that prematurity was a significant risk factor for early onset bacterial meningitis in neonates.

4.3 Association between meningitis among children and past medical history

Table (4.6): Association between meningitis among children and past medical history

Factor	Group		χ^2 (df)	Crude OR (95%CI)	*P* value
	Case N (%)	Control N (%)			
Did your child have a history of hospitalization					
No®	45 (53.6)	55 (64.0)	1.891 (1)	1.538 (0.832 - 2.843)	0.170
Yes	39 (46.4)	31 (36.0)			
Mean of hospitalization day = 4.91 , Median = 3.00 , STD = 8.799					
Did your child have an allergy					
No®	82 (95.3)	81 (93.1)	0.400 (1)	0.659 (0.179 - 2.421)	0.529
Yes	4 (4.7)	3(6.9)			
Did your child have a history of a head trauma or falling with a head injury					
No®	67 (77.9)	81 (93.1)	8.079 (1)	3.828 (1.447 - 10.132)	0.007
Yes	19 (22.1)	6 (6.9)			
Did your child have a history of surgical operation					
No®	80 (92.0)	83 (96.5)	1.649 (1)	2.421 (0.605 - 9.689)	0.212
Yes	7 (8.0)	3 (3.5)			
Anemia					
No®	60 (69.0)	71 (81.6)	3.738 (1)	1.997 (0.984 - 4.051)	0.055
Yes	27 (31.0)	16 (18.4)			
Did the family have a history of meningitis					
No®	69 (79.3)	81 (94.2)	8.302 (1)	4.226 (1.491 - 11.975)	0.007
Yes	18 (20.7)	5 (5.8)			

Table 4.6 showed that 45 (53.6%) of children from the case group and 55 (64.0%) of children from the control group did not have history of previous hospitalization, 39 (46.4%) of children from the case group and 31 (36.0%) of children from the control group

had a history of previous hospitalization (P= 0.170) which indicated statistically insignificant differences between the two groups and that history of previous hospitalization was not a significant risk factor for meningitis.

The results also showed that 82 (95.3%) of children from the case group and 81 (93.1%) of children from the control group did not have allergy, 4 (4.7%) of children from the case group and 3 (6.9%) of children from the control group had allergy (P= 0.529) which indicated statistically insignificant differences between the two groups and that allergy was not a significant risk factor for meningitis.

Moreover, 19 (22.1%) of children from the case group and 6 (6.9%) of children from the control group had a history of previous head trauma [OR 3.828, 95% CI (1.447 – 10.132), P= 0.007] which indicated statistically significant differences between the two groups and that history of previous head trauma was a significant risk factor for meningitis.

Also, 80 (92.0%) of children from the case group and 83 (96.5%) of children from the control group did not have history of previous surgical operation, 7 (8.0%) of children from the case group and 3 (3.5%) of children from the control group had a history of previous surgical operation (P= 0.212) which indicated statistically insignificant differences between the two groups and that history of previous surgeries was not a significant risk factor for meningitis.

The results also showed that 27 (31.0%) of children from the case group and 16 (18.4%) of children from the control group had anemia [OR 1.997, 95% CI (0.984 – 4.051), P= 0.055] which indicated statistically significant differences between the two groups and that anemia was a significant risk factor for meningitis. Furthermore, 18 (20.7%) of children from the case group and 5 (5.8%) of children from the control group had a history of family meningitis [OR 4.226, 95% CI (1.491 – 11.975), P= 0.007] which indicated statistically significant differences between the two groups and that history of family meningitis was a significant risk factor for meningitis.

The researcher believes that having family members with meningitis could be a source of meningitis for other family members because the disease is contagious and can be spread from one person to another. As a preventive measure, when a child is admitted to the hospital with meningitis, we notify the Department of Preventive Medicine and usually they visit the family at their home and give prophylactic treatment for all family members who came in contact with the sick child.

Similar results obtained by Olea et al., (2017) found that familial history of meningitis increased the probability of meningococcal diseases, and Swanson, (2015) found that recent penetrating head trauma and leak of CSF were risk factors for meningitis, while Al-Ani (2009) found that head trauma and family history of meningitis were insignificant risk factors for meningitis. Furthermore, Al Jarousha and Al Afifi, (2014) found that low hemoglobin level was among the most significant factors associated with developing meningitis.

On the other hand, inconsistent results obtained by Umaru et al., (2013) and Al-Ani (2009) who found that previous hospitalization with respiratory tract infection was significant risk factors for developing meningitis, and Bilukha and Rosenstein, (2005) reported that recent respiratory tract disease was associated with increased risk of meningitis. Other studies indicated that history of respiratory tract infection was a significant risk factor for meningitis (Stuart et al., 2002; Heyderman et al., 2004; Cohn et al., 2013, Chun et al., 2015; Hadjichristodoulou et al., 2016).

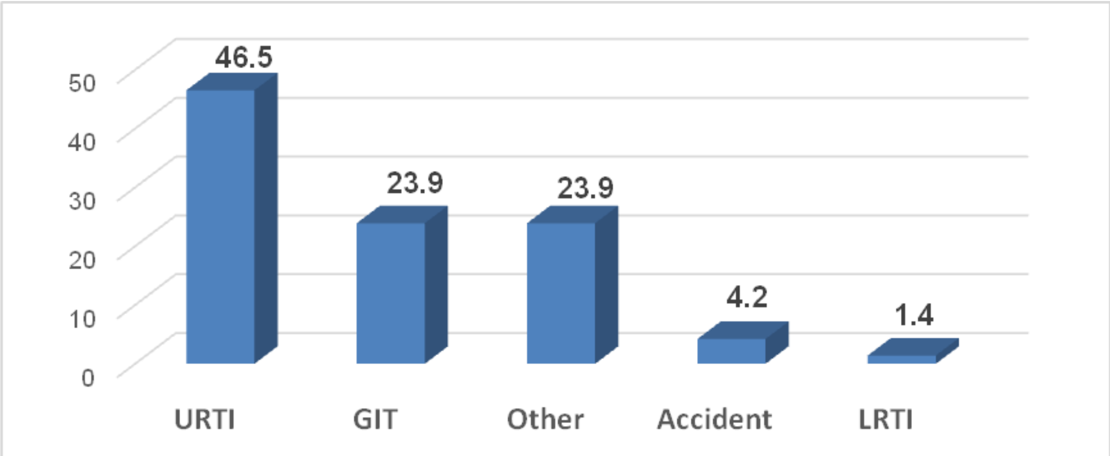

Figure (4.4): Reasons of previous hospitalization

As presented in figure (4.4), URTI was the most common cause of previous hospitalization accounted for 46.5% of cases, followed by GIT accounted for 23.9%, accidents accounted for 4.2%, LRTI accounted for 1.4%, and other causes accounted for 23.9%.

4.4 Association between meningitis among children and health behavior

Table (4.7): Association between meningitis and smoking

Factor	Group		χ2 (df)	Crude OR (95%CI)	*P* value
	Case N (%)	Control N (%)			
Smokers at home					
No®	30 (34.5)	51 (58.6)	10.186 (1)	2.692 (1.456 - 4.976)	0.002
Yes	57 (65.5)	36 (41.4)			
Amount of smoking / day					
< 1 package®	31 (51.7)	22 (57.9)	0.883 (20	1	
1 -2 packages	13 (21.7)	9 (23.7)		1.025 (0.373 - 2.816)	0.962
>2 packages daily	16 (26.6)	7 (18.4)		1.622 (0.572 - 4.602)	0.363
Exposed to passive smoking at home					
No®	44 (50.6)	59 (71.1)	7.483 (1)	2.402 (1.275 - 4.528)	0.007
Yes	43 (49.4)	24 (28.9)			

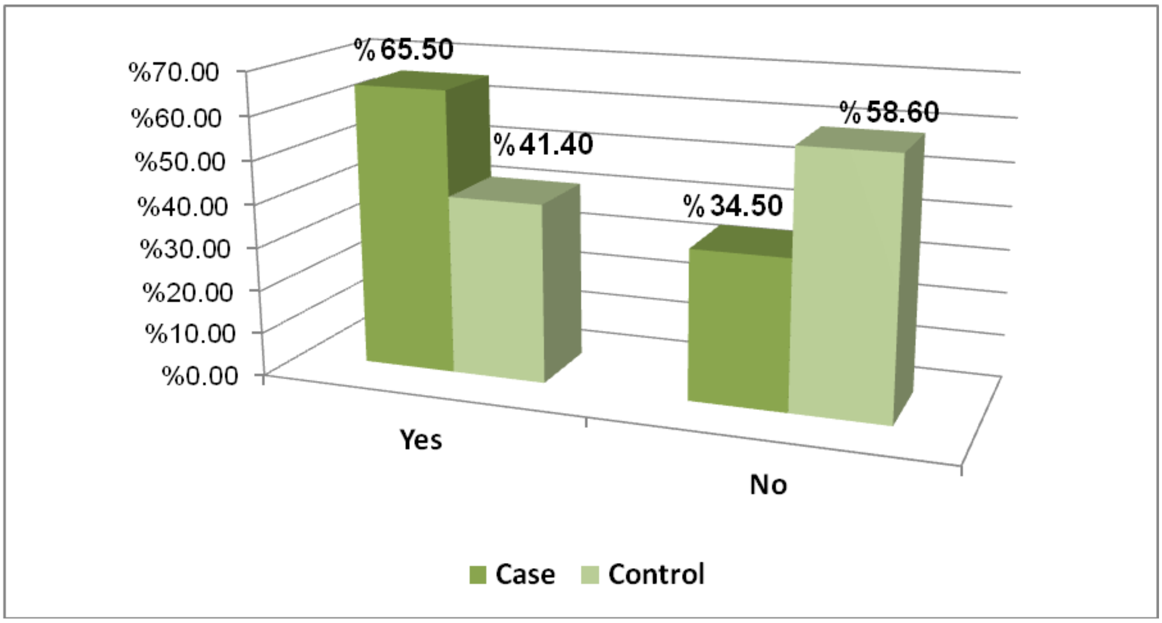

Figure (4.5): Presence of smokers at home

Table 4.7 and figure 4.5showed that 57 (65.5%) of children from the case group and 36 (41.4%) of children from the control group have smokers at their home [2.692, 95% CI (1.456 – 4.976), P= 0.002] which indicated statistically significant differences between the two groups and that having a smoker at home was a significant risk factor for meningitis.

Moreover, 31 (51.7%) of smokers from the case group and 22 (57.9%) of smokers from the control group smoke less than a package per day, 13 (21.7%) from the case group and 9 (23.7%) from the control group smoke one to two packages per day, 16 (26.6%) from the case group and 7 (18.4%) from the control group smoke more than two packages per day. These results reflected that having a smoker at home (regardless of the amount of smoking) was a significant risk factor for developing meningitis in the children.

In addition, 43 (49.4%) of children from the case group and 24 (28.9%) of children from the control group were exposed to passive smoking [OR 2.402, 95% CI (1.275 – 4.5280, P= 0.007] which indicated statistically significant differences between the two groups and that exposure to passive smoking was a significant risk factor for meningitis. These results revealed that exposure to tobacco smoke was a significant risk factor for meningitis, which emphasized that healthcare providers should increase people awareness about dangers of smoking inside homes which increase the chance to acquire health disturbances especially for young children and so fathers should not smoke indoors to avoid the risk of health problems for their children.

This result was supported by CDC report (2015) which indicated that active and passive smoking was a risk factor for the development of meningococcal disease. Iles et al., (2001) reported that children who had meningitis were significantly more likely to have parents who smoked inside the house than children who had not had meningitis. In addition, a case-control study conducted in Greece by Hadjichristodoulou et al., (2016) found that paternal smoking was a risk factors associated with IMD. Also, Umaru et al., (2013) reported that smoking was among the most important factors that influenced the occurrence of meningitis. Moreover, Bilukha and Rosenstein, (2005) found that active and passive smoking were significant risk factors for meningitis, and Murray et al., (2012) indicated that maternal smoking and passive smoking in the home doubled the risk of invasive meningococcal disease, while Fischer et al., (1997) reported that having a mother who smokes was the strongest independent risk factor for invasive meningococcal disease in children, and Yusuf et al., (1999) found that the crude rate of meningococcal disease was 5 times higher for children whose mothers smoked during pregnancy than for children whose mothers did not smoke. In addition, Al-Ani (2009) reported that passive smoking was a significant risk factor for developing meningitis among children under 5 years old. Also, Kriz et al., (2000) emphasized that both active and passive smoking have been found to increase the risk of IMD in children, and MacNeil et al., (2015) reported that more than two thirds of meningitis cases had a smoker in the household, while Chun et al., (2015) reported that passive cigarette smoke exposure was not associated with invasive pneumococcal disease.

Table (4.8): Association between meningitis and child's health behaviors

Factor	Group		χ^2 (df)	Crude OR (95%CI)	*P* value
	Case N (%)	Control N (%)			
Did your child have a chronic disease					
No®	80 (92.0)	81 (93.1)	0.083 (1)	1.181 (0.380 - 3.669)	0.773
Yes	7 (8.0)	6 (6.9)			
Does your child wash his hands before eating					
No®	18 (20.9)	17 (19.8)	0.036 (1)	0.931 (0.443 - 1.956)	0.850
Yes	68 (79.1)	69 (80.2)			
Did your child take medication without doctor's prescription					
No®	44 (50.6)	43 (49.4)	0.023 (1)	0.955 (0.527 - 1.730)	0.879
Yes	43 (49.4)	44 (50.6)			

Table 4.8 showed that 7 (8.0%) of children from the case group and 6 (6.9%) of children from the control group have chronic diseases, (P= 0.773) which indicated statistically insignificant differences between the two groups and that having chronic disease was not a significant risk factor for meningitis. The results also showed that 68 (79.1%) of children from the case group and 69 (80.2%) of children from the control group wash hands before eating, while 18 (20.9%) of children from the case group and 17 (19.8%) of children from the control group do not wash their hands before eating, (P= 0.850) which indicated statistically insignificant differences between the two groups and that washing hands before eating was not a significant risk factor for meningitis.

Moreover, 43 (49.4%) of children from the case group and 44 (50.6%) of children from the control group take medication without doctor prescription, 44 (50.6%) of children from the case group and 43 (49.4%) of children from the control group do not take medication without doctor prescription, (P= 0.879) which indicated statistically insignificant differences between the two groups and that taking medication without doctor prescription was not a significant risk factor for meningitis.

Previous studies found that factors that may compromise patients' immune system including; AIDS, and use of immunosuppressant drugs increased the risk for meningitis (Grenon et al., 2014; Martin et al., 2014; Perfect et al., 2010), and use of corticosteroids was associated with increased risk of meningitis (Bilukha and Rosenstein, 2005), while Chun et al., (2015) indicated that recent use of antibiotic was associated with invasive pneumococcal disease.

Table (4.9): Association between meningitis and presence of animals at home

Factor	**Group**		**χ^2 (df)**	**Crude OR (95%CI)**	***P* value**
	Case N (%)	**Control N (%)**			
Are there animals or birds in your house					
No®	49 (56.3)	63 (72.4)	4.911 (1)	2.036 (1.081 - 3.833)	0.028
Yes	38 (43.7)	24 (27.6)			
Did the child spend time with animals					
No®	59 (70.2)	70 (84.3)	4.722 (1)	2.282 (1.073 - 4.852)	0.032
Yes	25 (29.8)	13 (15.7)			

Table 4.9 showed that 38 (43.7%) of children from the case group and 24 (27.6%) of children from the control group have animals at their homes, [OR 2.036, 95% CI (1.081 – 3.833), P= 0.028] which indicated statistically significant differences between the two groups. The results also showed that 25 (29.8%) of children from the case group and 13 (15.7%) of children from the control group spend time with animals, [OR 2.282, 95% CI (1.073 – 4.852), P= 0.032] which indicated statistically significant differences between the two groups. These results reflected that having animals at home and coming in contact with animals were significant risk factors for meningitis. This result disagreed with

theresults obtained by Al-Ani, (2009) which indicated that animal breeding was insignificant risk factor for meningitis.

Having animals indoors could be a source of transmission of pathogens. Also, feces and secretions from animals are usually contaminated with different types of pathogens, and coming in contact with these secretions would transmit different types of diseases to children who have been in contact with animals and their secretions. So, it is important to grow animals outdoors and use proper methods to get rid of their feces. Also, the animals should be given appropriate treatments and prophylactic vaccines to keep them healthy and not a source of disease transmission.

Table (4.10): Association between meningitis and feeding during first six months and weaning

Factor	Group		χ^2 (df)	Crude OR (95%CI)	*P* value
	Case N (%)	Control N (%)			
Methods of feeding from birth to six months					
Breast feeding®	32 (37.2)	29 (33.7)	0.621 (2)	1	
Bottle feeding	8 (9.3)	11 (12.8)		0.659 (0.233 - 1.865)	0.432
Mixed	46 (53.5)	46 (53.5)		0.906 (0.474 - 1.732)	0.766
What's the child's age of weaning					
Still®	56 (65.1)	44 (58.7)	0.729 (2)	1	
From 1 to 12 Months	17 (19.8)	17 (22.7)		0.786 (0.360 - 1.713)	0.544
Above 12 Months	13 (15.1)	14 (18.7)		0.730 (0.311 - 1.170)	0.468

Table 4.10 showed that 32 (37.2%) of children from the case group and 29 (33.7%) of children from the control group had breast feeding during the first six months of life, 8 (9.3%) of children from the case group and 11 (12.8%) of children from the control group had bottle feeding (P= 0.432), while 46 (53.5%) of children from the case group and 46 (53.5%) of children from the control group had mixed (breast and bottle) feeding (P=

0.766). These results indicated statistically insignificant differences between the two groups and that method of feeding during early stage of life was insignificant risk factors for meningitis. In addition, the results showed that 56 (65.1%) of children from the case group and 44 (58.7%) of children from the control group still on breast or bottle feeding, 17 (19.8%) of children from the case group and 17 (22.7%) of children from the control group have been weaned between one to 12 months (P= 0.544), while 13 (15.1%) of children from the case group and 14 (18.7%) of children from the control group have been weaned after 12 months (P= 0.468). These results indicated statistically insignificant differences between the two groups and that age of weaning was insignificant risk factors for meningitis. Different results obtained by Al-Ani (2009) which showed that bottle feeding was significant risk factors for developing meningitis, while Al Jarousha and Al Afifi, (2014) found that malnutrition was among the most significant factors associated with developing meningitis.

It is obvious that breast feeding is a healthy practice that gives the child natural immunity and increase their resistance to disease. Also, many women give their children bottle feeding as a complement with breast feeding, and by asking some women they said that they clean the bottle frequently with soap and boiling water to keep the bottle clean, also, they boil the water before mixing with milk formula, and these practices explains our results that method of feeding was not significant risk factor for meningitis.

Table (4.11): Association between meningitis and water supply and toilet facility

Factor	Group		χ2 (df)	Crude OR (95%CI)	*P* value
	Case N (%)	Control N (%)			
What's the main source of drinking water					
Filter®	81 (93.1)	63 (72.4)	Fisher 23.984 (2)	1	
Bottle	0 (0.0)	18 (20.7)		0.0	0.998
The same as the source of water	6 (6.9)	6 (6.9)		0.778 (0.239 - 2.527)	0.676
What's the main source of the washing water					
Buying water tank®	2 (2.3)	9 (10.5)	5.954 (3)	1	
Municipal water	77 (88.5)	69 (80.2)		5.022 (1.049 - 24.047)	0.043
UN agency	1 (1.1)	1 (1.1)		0	1.000
Household well	7 (8.0)	8 (9.3)		3.938 (0.627 - 24.731)	0.144
Access to toilet facility					
Modifying, new®	65 (74.7)	68 (79.1)	0.462 (1)	1.279 (0.629 - 2.600)	0.497
Un-modifying, old	22 (25.3)	18 (20.9)			

Table 4.11 showed that 81 (93.1%) of family children from the case group and 63 (72.4%) of family children from the control group had filtered water supply for drinking, none of children from the case group and 18 (20.7%) of family children from the control group had bottle water for drinking (P= 0.998), while 6 (6.9%) of children from the case group and 6 (6.9%) of family children from the control group had tab water as the source of drinking water (P= 0.676). These results indicated statistically insignificant differences between the two groups and that source of drinking water was insignificant risk factors for meningitis. Moreover, the results showed that 2 (2.3%) of family children from the case group and 9 (10.5%) of family children from the control group buying water tanks for washing, 77 (88.5%) of family children from the case group and 69 (80.2%) of family children from the

control group had municipal water supply for washing [OR 5.022, 95% CI (1.049 – 24.047), P= 0.043], while 7 (8.0%) of family children from the case group and 8 (9.3%) of family children from the control group had their own household well of water supply for washing (P= 0.144). These results indicated statistically significant differences between the two groups and that water supply from municipality was significant risk factors for meningitis. Different results obtained by Al-Ani (2009) which showed that source of water supply was insignificant risk factor for meningitis.

The results also showed that 68 (79.1%) of children from the control group 65 (74.7%) of children from the case group have modified new toilet facility at their homes, while 18 (20.9%) of children from the control group and 22 (25.3%) of children from the case group have unmodified old toilet facility at their homes (P= 0.497). These results indicated statistically insignificant differences between the two groups and that type of toilet at home was insignificant risk factors for meningitis.

According to CDC (2009), viral meningitis is most commonly spread through fecal contamination, thus the risk of infection can be decreased by changing the behavior that led to transmission, so, access to clean toilet is fundamental to control the transmission of meningitis.

Table (4.12): Association between meningitis and activity and rest, and schooling

Factor	Group		χ^2 (df)	Crude OR (95%CI)	*P* value
	Case N (%)	Control N (%)			
Does the child play with other children in the street					
Yes	73 (83.9)	57 (65.5)	7.787 (1)	2.744 (1.332 - 5.654)	0.006
No®	14 (16.1)	30 (34.5)			
Where does he/she do the activity					
At home®	65 (90.3)	55 (98.2)	3.386 (1)	5.923 (0.707 - 49.635)	0.101
At Street	7 (9.7)	1 (1.8)			
Does your child sleep well					
Yes	68 (79.1)	73 (84.9)	0.984 (1)	0.673 (0.307 - 1.477)	0.323
No®	18 (20.9)	13 (15.1)			
Mean of sleeping hours= 10.31, Median = 11.0, STD = 2.79					
Does your child join at a school or a Kindergarten					
Yes	18 (20.7)	12 (13.8)	1.450 (1)	1.630 (0.732 - 3.630)	0.231
No®	69 (79.3)	75 (86.2)			

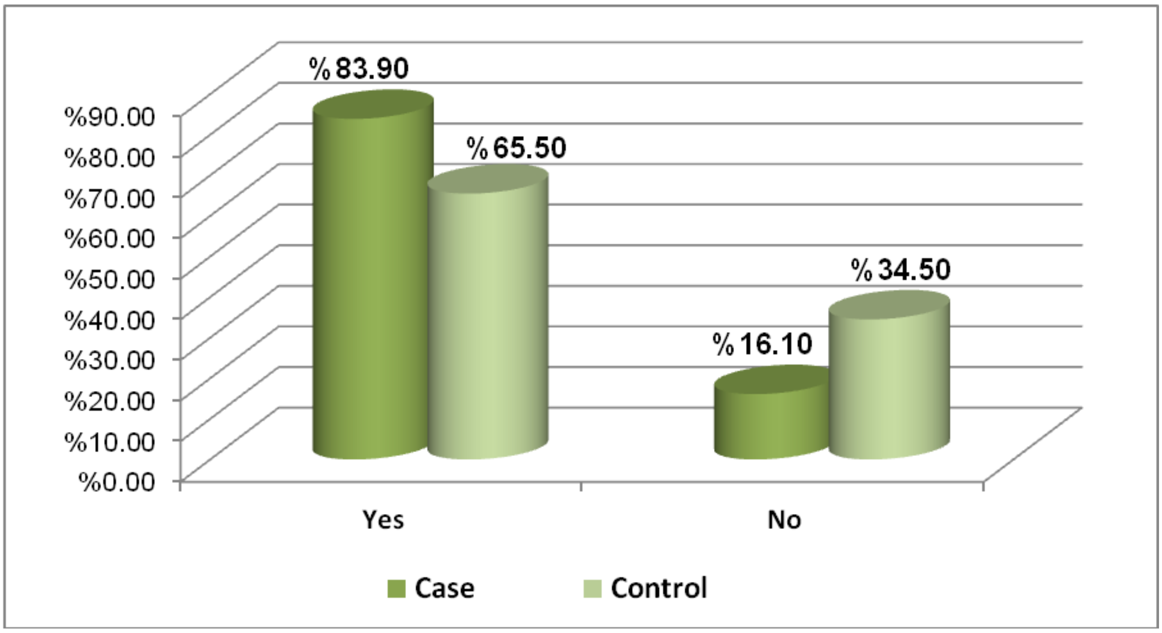

Figure (4.6): Playing with other children in the street

Table 4.12 and figure 4.6showed that 73 (83.9%) of children from the case group and 57 (65.5%) of children from the control group play with other children in the street, [OR 2.744, 95% CI (1.332 – 5.654), P= 0.006], which indicated statistically significant differences between the two groups and that playing with other children in the street was a significant risk factor for meningitis. Playing with other children is common in our society because of the crowded houses with big families and there are inadequate parks for playing and leisure time. Being in contact with carriers or sick children may transmit the disease to other children and increase the chance of acquiring communicable disease, so, vulnerable children should be careful and avoid coming in contact with other children in crowded areas to avoid catching the pathogens and acquiring meningitis.

The results also showed that 65 (90.3%) of children from the case group and 55 (98.2%) of children from the control group do their physical activities at home (P= 0.101). These results indicated statistically insignificant differences between the two groups and that place of performing physical activities was insignificant risk factors for meningitis. Moreover, the results showed that 68 (79.1%) of children from the case group and 73 (84.9%) of children from the control group sleep well, while 18 (20.9%) of children from the case group and 13 (15.1%) of children from the control group do not sleep well (P= 0.323). These results indicated statistically insignificant differences between the two groups and that amount of sleeping was insignificant risk factors for meningitis.

The results also showed that 18 (20.7%) of children from the case group and 12 (13.8%) of children from the control group are going to school or kindergarten (P= 0.231). These results indicated statistically insignificant differences between the two groups and that going to school or kindergarten was insignificant risk factors for meningitis.

Schools and kindergarten are crowded places and they are considered as a source of disease transmission. In GS, the department of school health make frequent visits to schools and perform physical exams and checks to identify sick children and send them to clinics and hospitals for proper treatment. In addition, identified children with communicable disease are usually sent home on sick leave to avoid transmission of disease to other children. Moreover, health education programs are carried out in schools to increase teachers and students awareness of some communicable diseases and healthy practices to maintain health of children.

Similar results obtained by Umaru et al., (2013) which indicated that climate and geographical location, environment, urbanization, and recreational spaces contributed to the spread of meningococcal meningitis. Other studies indicated that children in schools and child care facilities are at increased risk of meningococcal meningitis (Grenon et al., 2014; Martin et al., 2014; Perfect et al., 2010), and Bilukha and Rosenstein, (2005) reported that new residence and moving to a new school was associated with increased risk of meningitis.

4.5 Predictor risk factors of meningitis among children

All variables with P-value ≤ 0.10 in bivariate analysis were employed in multivariate analysis and consecutive exclusions of variables with least significance level was done till achieving the model with statistically significant predictor variables for meningitis among children in Gaza governorates and the final model of main predictor risk factors for meningitis occurrence as shown in table (4.13).

Table (4.13): Multi variate analysis of risk factors of meningitis among children in Gaza governorates(final model)

Factor	Beta coefficient	Wald	Crude OR (95% CI)	Adjusted OR (95%CI)	*P* value*
Father Work					
Yes	0.472	6.932	0.448 (0.238-0.842)	0.288 (0.144-0.728)	0.008 *
No ®					
Type of family					
Nuclear ®	0.000	8.182	2.933 (1.263-6.812)	0.999 (0.998-1.000)	0.004*
Extended					
Number of Children under 6 years					
One ®	0.233	10.184	1	0.475 (0.300-0.750)	0.001*
Two			0.472 (0.211-1.054)		
Three			0.204 (0.085-0.486)		
Four and more			0.180 (0.040-0.805)		
Did your child have a history of a head trauma or falling with a head injury					
No ®	0.627	2.765	3.828 (1.44-10.132)	2.839 (0.830-9.711)	0.015 *
Yes					
Did the family have a history of meningitis					
No ®	0.620	4.990	4.226 (1.491-11.97)	3.999 (1.185-13.490)	0.025 *
Yes					
Are there animals or birds in your house					
No ®	0.416	4.381	2.282 (1.073-4.852)	2.389 (1.057-5.400)	0.036 *
Yes					

Adjusted OR findings showed that fathers' work was significant protective factor [OR 0.288, 95% CI (0.144 – 0.728), P= 0.008] which means that fathers who are working are able to afford life expenses and healthy nutritional food which contributes to healthy life to their children. Also, living in extended family was significant protective factor [OR 0.999, 95% CI (0.998 – 1.000), P= 0.004] which indicated that living in extended family with older family members and having more experience in growing children, and that will help younger mothers in proper ways of dealing with their children and maintain healthy behaviors. In addition, having higher number of children in the family was significant protective factor [OR 0.475, 95% CI (0.300 – 0.7500, P= 0.001] which means that having more children gives the mother more experience in growing her children and ability to detect abnormalities in their health. Moreover, history of head trauma was significant risk factor [OR 2.839, 95% CI (0.830 – 9.711), P= 0.015] which means that having a history of head trauma or head injury predispose the child to acquiring meningitis. Furthermore, the results reflected that family history of meningitis was significant risk factor [OR 3.999, 95% CI (1.185 – 13.490), P= 0.025] which means that having a family member with meningitis increase the chance of disease transmission to other family members. Also, animals and birds breeding inside the home was significant risk factor [OR 2.389, 95% CI (1.057 – 5.400), P= 0.036], which means that coming in contact with animals and their feces and secretions is a source of contamination and increase the chance of acquiring meningitis.

Chapter Five

Conclusion and Recommendations

5.1 Conclusion

Meningitis is an important public health problem of childhood that requires special attention and prompt treatment. While most children with meningitis recover, it can cause serious complications such as brain damage, hearing loss, or learning disabilities. This study aimed to identify risk factors that may contribute to the development of meningitis among children in GS.

The study tackled occurrence of meningitis in relation to sociodemographic factors of parents including (parents' age, parents' education, working status, family income) and medical history and selected health behaviors.

The sample of the study consisted of 87 meningitis children in the case group and 87 healthy children in the control group. The study participants were selected from the five governorates of Gaza from the age of one month to 12 years old.

Bivariate analysis between the case group and the control groupto identify risk factors of meningitis indicated that low family income, living in extended family, preterm birth, history of head trauma, anemia, family history of previous meningitis, presence of smokers inside the house, exposure to passive smoking, breeding animals inside the house, being in contact with animals,using municipal water supply, and playing with other children in the street were significant risk factors of meningitis among children.In addition, bivariate analysis between the two groups of children showed that father's work and higher number of children in the family were significant protective factors.

On the other hand, insignificant risk factors included type of house, crowd, parents, age, parents, education, previous hospitalization and previous surgical procedures, health behaviors, method of feeding during infancy, and schooling.

A prediction model was employed using multivariate logistic regression analysis showed that the main predictor risk factors of meningitis among children in Gaza governorates were history of head trauma, family history of meningitis, and breeding animals and birds inside the home. On the other hand, multivariate logistic regression analysis showed that fathers' work, living in extended family, and having higher number of children in the family were significant protective factors of meningitis.

5.2 Recommendations

In the light of study results, the researcher recommend the following:

- Raise parents awareness of meningitis including its symptoms, and the need to seek medical treatment to avoid complications.
- Parents need to be educated about the risk of indoor smoking, and efforts should be directed toward reducing smoking inside households to reduce the incidence of meningitis.
- Activate the role of department of school health through regular visits to schools, screening of children for possible health problems, and increase awareness about communicable diseases.
- Early diagnosis and prompt treatment of URTI to reduce the risk of meningitis.
- Disclosure of animal breeding inside houses and restrict children's contact with animals.

5.3 Suggestions for further research

- To carry out a study aiming to examine parents awareness of meningitis and its consequent complications on their children.
- To carry out a study aiming to identify knowledge, attitudes, and practices of healthcare providers about early diagnosis and treatment strategies of different types of meningitis.
- To carry out a study about the role of school health in screening and early detection of meningitis among school age children.

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Annexes

Annex (1)Questionnaire

الأم الفاضلة:

تحية طيبة وبعد:

أنا الباحث أحمد يوسف إسماعيل الملاحي طالب في جامعة القدس أبوديس ماجستير الصحة العامة تخصص علم الأوبئة أقوم بإجراء بحث عن أهم المخاطر المسببة لمرض التهاب السحايا عند الأطفال في قطاع غزة من سن شهر إلى اثنى عشر سنة .

مشاركتك سيدتي في هذه الدراسة سوف تساعد الباحث على معرفة المخاطر المسببة لمرض التهاب السحايا لأطفال قطاع غزة والتي ستساعد في محاولة السيطرة على هذا المرض .

المشاركة من قبلك سيدتي لا تشكل أي خطر أو تكلفة عليك وأي معلومة في هذه الدراسة سيتم استخدامها فقط لغرض البحث العلمي ولن تستخدم لأي أغراض أخرى وسوف يتم التعامل معها بطريقة سرية.

عدد الأطفال الذين سوف يشاركون بصحبة أمهاتهم في هذه الدراسة ما يقارب 160 مشارك وقد تم اختياركم للمشاركة في هذه الدراسة بطريقة إحصائية عشوائية ولكم حرية الاختيار بالموافقة أو الرفض.

في حال اختيار الموافقة , نشكركم على هذا القرار وسوف تكون المقابلة في وقت يستغرق من 15 إلى 20 دقيقة ولكم حرية الإجابة على جميع الأسئلة أو الامتناع عن الإجابة عن أي سؤال أو الامتناع عن الإجابة وعدم الاستمرار, إذا كان هناك أي استفسار أو سؤال فإنه باستطاعتك طلب التوضيح أو الإجابة عليه في أي وقت.

مع خالص الشكر

الباحث: أحمد الملاحي

Serial number: ☐☐	Date: …./…../ 2017
Participant: ☐Case ☐Control	Hospital ……………………………

A . Socio demographic characteristics

Type of living area :	☐City	☐Camp	☐Village
Type of building:	☐Asbestos	☐Concrete	☐Others …………
Type of house:	☐ Flat	☐ Tent	☐Land
Type of family:	☐Nuclear family	☐Extended family	
Number of children:	☐One☐Two☐Three☐Four and more		

Age of mother: ☐Less than 30 years☐30 years and above

Age of father: ☐Less than 30 years☐30 years and above

Mother education: ☐ Preparatory or less ☐ Secondary ☐Univirsity ☐ Not educated

Father education: ☐ Preparatory or less ☐ Secondary ☐Univirsity ☐ Not educated

Mother working status: ☐ Working☐ Do not work

Father working status: ☐ Working☐ Do not work

Family income: ☐ Less than poverty line☐ Above poverty line

B. Child personal information

Child gestational age: ☐ Full-term ☐ Pre-term ☐ Post-term

Order of this child in the family :	…………..

C. Past medical history

Did your child have history of hospitalization ? ☐Yes ☐ No

- If yes , Reasonse of hospitalization ?

☐ LRTI ☐ URTI ☐GIT ☐ Accident ☐ Otheres ………………………..

If yes, How long ? ……………………………………………………………………..

Did your child have allergy? ☐Yes ☐ No

Did your child have history of head trauma? ☐Yes ☐ No
Did your child havea history of surgical operation? ☐ Yes ☐ No
Child hemoglobin level ? ……………………… gm.
Did your child havea history of meningitis? ☐ Yes ☐ No
D. Health behavior
Presence of smokers at home:☐ Yes ☐ No
Amount of smoking / day: ☐< 1 package ☐ 1 – 2 packages ☐> 2 packages
Had the child been exposed to passive smoking at home?☐ Yes ☐ No
Does your child have chronic disease? ☐ Yes ☐ No
Does your child wash hands before eating? ☐ Yes ☐ No
Does your child take medication without doctor's prescription? ☐ Yes ☐ No
If yes , What type of medication : ……………………………………………………….
Are there animals or birds in your home? ☐ Yes ☐ No
Did your child spend time with animals? ☐ Yes ☐ No
Method of feeding from birth to six months:☐Breast feeding ☐Bottle feeding ☐Mixed
Age of weaning: ☐Still ☐1 – 12 months ☐After 12 months
Source of drinking water: ☐Filter☐ Bottle (Mineral water)☐ The same as the source of water
Source of washing water: ☐Municipal water ☐Buying water tanks ☐UN agency ☐ Household well
Access to toilet facility: ☐Modified , new ☐Unmodified , old
Does your child Play with children in the street ?☐Yes ☐ No
Where does your child do activity leisure? ☐At home ☐At street
Does your child sleep well? ☐Yes ☐ No
Does your child join at a school or kindergarten? ☐Yes ☐ No

Annex (2): Approval from Al Quds university

Al-Quds University

Jerusalem

School of Public Health

جامعة القدس

القدس

كلية الصحة العامة

التاريخ: 2017/9/16

حضرة الدكتور/ رامي العبادلة المحترم

مدير عام تنمية القوى البشرية–وزارة الصحة

السلام عليكم ورحمة الله،،،

الموضوع: مساعدة الطالب أحمد الملاحي

نشكر لكم دعمكم الدائم لمسيرة العلم والتعليم وخصوصاً دعم كلية الصحة العامة وطلابها، ونود أعلامكم بأن الطالب المذكور أعلاه يقوم بعمل بحث كمتطلب للحصول على درجة الماجستير في الصحة العامة–مسار علم الأوبئة بعنوان:

"Risk Factors of Meningitis among Children in Gaza Governorates: A Case-Control Study"

وعليه نرجو من سيادتكم التكرم بالموافقة على تسهيل مهمة الطالب في إنجاز هذا البحث حيث تشمل عينة الدراسة الأطفال من عمر شهر حتى عمر 12 عام المصابين بمرض التهاب السحايا والمتواجدين بأقسام الباطنة أطفال في المستشفيات الحكومية والتابعة لوزارتكم الموقرة .

و اقبلوا فائق التحية و الاحترام،،،

د. بسام أبو حمد

منسق عام برامج الصحة العامة

فرع غزة

نسخة:

– الملف

Jerusalem Branch/Telefax 02-2799234

Gaza Branch/Telefax 08-2644220 -2644210

P.O. box 51000 Jerusalem

فرع القدس / تلفاكس 02-2799234

فرع غزة / تلفاكس 08-264420-2644210

ص.ب 51000 القدس

Annex (3): Approval from Helsinki committee

المجلس الفلسطيني للبحث الصحي

Palestinian Health Research Council

تعزيز النظام الصحي الفلسطيني من خلال مأسسة استخدام المعلومات البحثية في صنع القرار

Developing the Palestinian health system through institutionalizing the use of information in decision making

Helsinki Committee

For Ethical Approval

Date: 2017/08/07 **Number:** PHRC/HC/244/17

Name: AHMED Y. ALMALAHY الاسم:

We would like to inform you that the committee had discussed the proposal of your study about:

نفيدكم علماً بأن اللجنة قد ناقشت مقترح دراستكم حول:

Risk Factors of Meningitis among Children in Gaza Governorates: Case-Control Study

The committee has decided to approve the above mentioned research. Approval number PHRC/HC/244/17 in its meeting on 2017/08/07

و قد قررت الموافقة على البحث المذكور عاليه بالرقم والتاريخ المذكوران عاليه

Signature

Member **Member**

Chairman

Genral Conditions:-

1. Valid for 2 years from the date of approval.
2. It is necessary to notify the committee of any change in the approved study protocol.
3. The committee appreciates receiving a copy of your final research when completed.

Specific Conditions:-

E-Mail:pal.phrc@gmail.com

Gaza - Palestine غزة - فلسطين

شارع النصر - مفترق العيون

Annex (4): Approval from MOH

State of Palestine
Ministry of health

دولة فلسطين
وزارة الصحة

التاريخ:01/10/2017
رقم المراسلة 165982

السيد : رامي عيد سليمان العبادله المحترم

مدير عام بالوزارة /الإدارة العامة لتنمية القوى البشرية - /وزارة الصحة

السلام عليكم ،،،

الموضوع/ تسهيل مهمة الباحث// أحمد الملاحي

التفاصيل //
بخصوص الموضوع أعلاه، يرجي تسهيل مهمة الباحث/**أحمد يوسف الملاحي**
الملتحق ببرنامج الماجستير في الصحة العامة – مسار علم الوبائيات- جامعة القدس أبوديس في إجراء بحث بعنوان:-
"Risk Factors of Meningitis among Children in Gaza Governorates: A Case - Control Study"
حيث الباحث بحاجة لتعبئة إستبانة من عدد من أمهات الأطفال الذين يعانون من التهاب السحايا المنومين في مستشفيات قطاع غزة الحكومية التي تقدم خدمة لهؤلاء الاطفال.
نأمل توجيهاتكم لذوي الاختصاص بضرورة الحصول على الموافقة المستنيرة من ذوي الاطفال الذين هم على استعداد للمشاركة في البحث ومن ثم السماح للباحث بالتواصل معهم، بما لا يتعارض مع مصلحة العمل وضمن أخلاقيات البحث العلمي،ودون تحمل الوزارة أي أعباء أو مسئولية.
ملاحظة / تسهيل المهمة الخاص بالدراسة أعلاه صالح لمدة 6 اشهر من تاريخة.

وتفضلوا بقبول التحية والتقدير،،،

محمد ابراهيم محمد السرساوي
مدير دائرة/الإدارة العامة لتنمية القوى البشرية -

2/10/2017

التحويلات

■ محمد ابراهيم محمد السرساوي(مدير دائرة)	← رامي عيد سليمان العبادله(مدير عام بالوزارة)	إجراءاتكم بالخصوص(01/10/2017)
■ رامي عيد سليمان العبادله(مدير عام بالوزارة)	← عبد اللطيف محمد محمد الحاج(مدير عام بالوزارة)	إجراءاتكم بالخصوص(02/10/2017)
■ عبد اللطيف محمد محمد الحاج(مدير عام بالوزارة)	← مصطفى سليم عبد الكحلوت(مدير مستشفى)	إجراءاتكم بالخصوص(02/10/2017)
■ عبد اللطيف محمد محمد الحاج(مدير عام بالوزارة)	← محمد محمد عبد الحليم ابو سلميه(مدير مستشفى)	إجراءاتكم بالخصوص(02/10/2017)
■ عبد اللطيف محمد محمد الحاج(مدير عام بالوزارة)	← ماجد محمد عبد الكريم حماده(مدير وحدة)	إجراءاتكم بالخصوص(02/10/2017)
■ عبد اللطيف محمد محمد الحاج(مدير عام بالوزارة)	← محمد خليل محمد زقوت(مدير)	إجراءاتكم بالخصوص(02/10/2017)
■ عبد اللطيف محمد محمد الحاج(مدير عام بالوزارة)	← يوسف فوزي اسماعيل العقاد(مدير مستشفى)	إجراءاتكم بالخصوص(02/10/2017)
■ محمد خليل محمد زقوت(مدير)	← عمر عبد الله حسين الاسطل(مدير دائرة)	إجراءاتكم بالخصوص(02/10/2017)
■ محمد خليل محمد زقوت(مدير)	← بيان مصباح غانم شراب(مدير صيدلية)	إجراءاتكم بالخصوص(02/10/2017)

Gaza Tel. (+970) 8-2846949
Fax (+970) 8-2826295

غزة تلفون. (+970) 8-2846949
فاكس (+970) 8-2826295

Annex (5): List of experts who judged face validity of questionnaire

Name	**Place of work**
Dr. Yehia Abed	Al Quds University
Dr. Basam Abu Hamad	Al Quds University
Dr. Khitam Abu Hamad	Al Quds University
Dr. Ashraf al Jedi	The Islamic University – Gaza
Dr. Areefa Al Buhery	The Islamic University – Gaza
Dr. Ayman Al Zahar	European Gaza Hospital
Dr. Ahmad Jbara	European Gaza Hospital
Dr. Eyad Al Sabe	European Gaza Hospital

Annex (6): Diagnosing viral meningitis

Cause	**Key diagnostic test**	**Other potentially useful tests**
Enteroviruses	CSF PCR*	Throat and rectal swabs—culture, PCR (positive for longer than CSF)
Herpes simplex virus (HSV)	CSF PCR*	HSV type specific serology. Detection in genital lesions—PCR, culture, immunofluorescence, electron
Varicella zoster virus	CSF PCR*	Detection in skin lesions—PCR, culture, immunofluorescence, electron microscopy, Tzanck
HIV	Serology*	Serial IgG or combined IgG and antigen tests—seroconversion? HIV viral load (plasma, CSF)
Mumps	Serology (serum, oral fluid)	PCR (throat swab, urine, EDTA blood, oral fluid)
Epstein-Barr virus (EBV)	EBV specific serology, VCA IgM and IgG,	CSF PCR. Monospot test

Source: Logan and MacMahon, 2008

CSF=cerebrospinal fluid; EBNA=Epstein-Barr nuclear antigen; PCR=polymerase chain reaction;

VCA=viral capsule antigen.

Annex (7): CSF findings in different forms of meningitis

Type	Glucose	Protein	Cells
Acute bacterial	Low	High	PMNs, often > 300/mm^3
Acute viral	Normal	Normal or high	mononuclear, < 300/mm^3
Tuberculous	low	high	mononuclear and PMNs, < 300/mm^3
Fungal	low	high	< 300/mm^3
Malignant	low	high	usually mononuclear

Source: Drew and Krentz (2005). PMN = Polymorphonuclear

Annex (8): Antibiotic recommendations for bacterial meningitis

Bacterial organism	Recommended antibiotics (IV)	Treatment duration
Streptococcus pneumonia	Vancomycin + 3rd generation cephalosporin (Cefotaxime or Ceftriaxone).	10 – 14 days
Neisseria meningitidis	3rd generation cephalosporin (cefotaxime or ceftriaxone) + Penicillin G or Ampicillin (depending on sensitivity).	5 – 10 days
Haemophilus influenza	3rd generation cephalosporin (cefotaxime or ceftriaxone)	7 – 10 days
Listeria monocytogenes	Ampicillin or Penicillin G ± aminoglycosides.	14 – 21 days
GBS	Ampicillin or Penicillin G ± aminoglycosides.	14 – 21 days
E coli	3rd generation cephalosporin (cefotaxime or ceftriaxone)	21 days

Source: Pick et al., (2016).