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Maternal mortality in Trondheim between 1830 and 1907

Master's thesis

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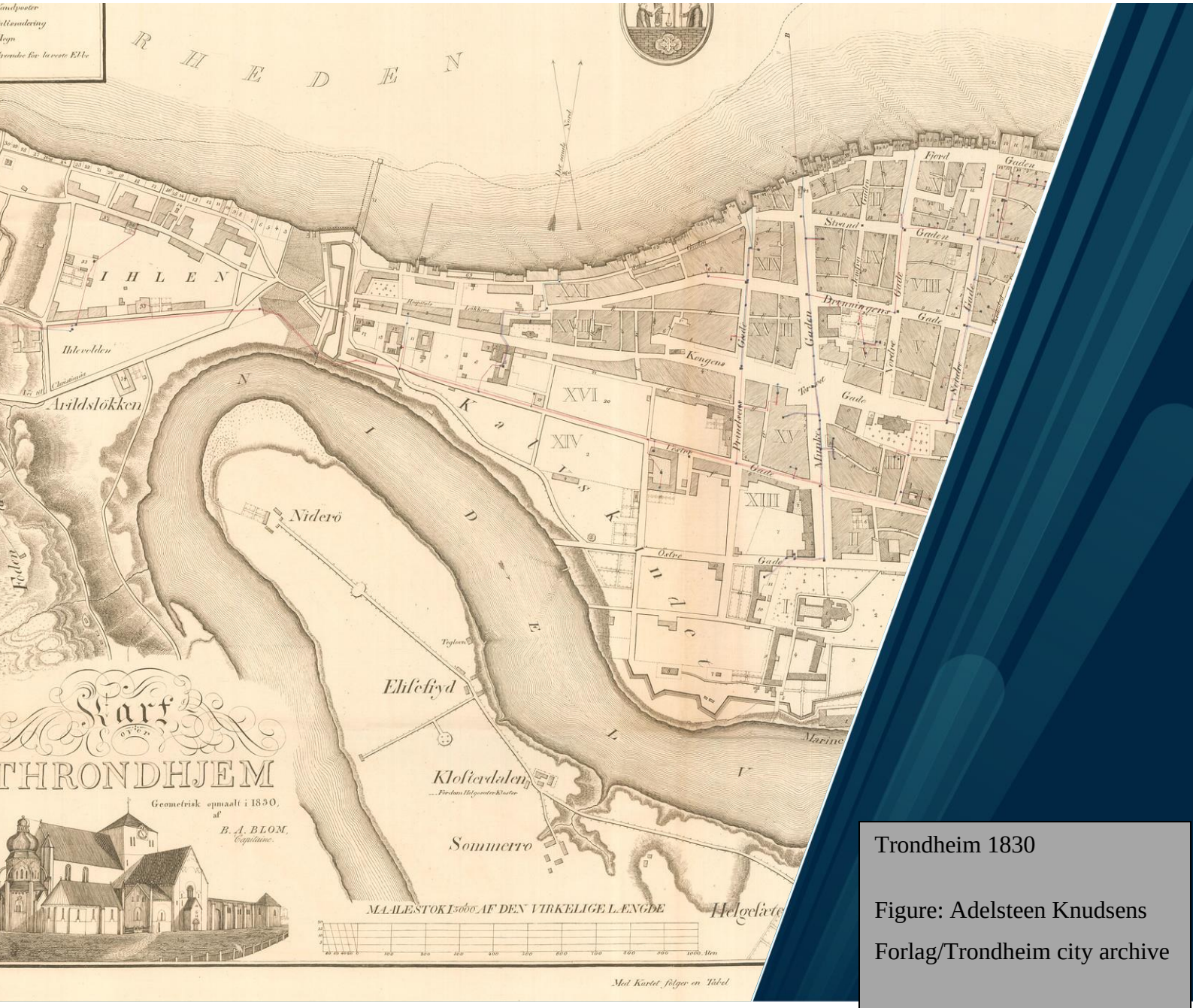

Trondheim 1830

Figure: Adelsteen Knudsens Forlag/Trondheim city archive

Preface

Before proceeding to the acknowledgements, some foundations need to be established. Firstly, this thesis focuses on studying the maternal mortality of women in Trondheim, Norway during the 19th and 20th centuries. Defining the term "woman" in relation to this study poses some challenges. Historically, girls were considered women after their first menstruation, although this definition is somewhat outdated. In modern terms, a woman is typically considered to be above the age of 18, i.e., of legal age. However, since this study pertains to historic maternal mortality, the term "women" will be used to encompass all individuals, regardless of their age. The term "fertile age" will be central to our discussion, defined as the age range between 15 and 49. Since the study focuses on maternal mortality caused by pregnancy, any recorded deaths related to pregnancy or childbirth will be of interest, even if they involve underage girls according to today's classifications. Therefore, the term "women" will be consistently used throughout the study. Secondly, it is also important to note the usage of the term "population" in this thesis. The population under consideration comprises all women aged 15-49, as well as the number of live births in the period. Understanding this aspect is crucial when examining the results, as it forms an essential part of the statistical discussion. The dataset primarily consists of numbers and categories, and it may be tempting to view the data solely as numerical values. However, it is crucial to always bear in mind that these numbers represent real human beings. The human element within a dataset almost always influences a case study in some manner. Now, let us proceed to the acknowledgements.

I want to start by acknowledging Professor Hilde L. Sommerseth for her patience and understanding nature. This study would not be possible without your guidance, and I am forever grateful for your dedication to this thesis.

I would also like to acknowledge Trygve Andersen for helping me troubleshoot when encountering issues and challenges in Microsoft Access 2016.

I also want to thank my significant other, Emilie F. Bruvoll. Had it not been for her dedication to my work on this study, and her taking responsibility for our children, this study would not have been finished until 2024, if finished at all.

Abstract

Maternal healthcare emerged as a significant concern in Norway during the 19th century, leading to the implementation of laws that aimed to establish a more centralized and professionalized midwifery service. In Trondheim, efforts were made to increase the education of midwives in response to these developments. However, it was not until 1908 that the city established its first dedicated maternity hospital. This thesis focuses on examining the rate of maternal mortality in Trondheim and comparing it with the overall mortality rate among women in the city from 1830 to 1907. The statistics show a maternal mortality that drastically increases between 1850 and 1864, and an increase in the number of deaths caused by puerperal sepsis in the later part of the period. As well as this, the maternal mortality exceeds the rate of total female mortality between 1850 and 1874, indicating that the women in Trondheim between the ages 15 and 49 were at a higher risk of death during or shortly after childbirth. The results indicate a lack of knowledge of what caused maternal death during the 19th century, alongside a developing understanding of sepsis as a cause of maternal death.

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1 Introduction

The 19th century was a period in Norwegian history characterized by significant changes in both society and public health. These changes included shifts in politics and the system of government, the dissolution of the union with Denmark and subsequently entering a union with Sweden, population and economic growth, changes in public health and the practice of medicine, the implementation of the "Sunhedsloven" in 1860, and much more.[1] The population growth in the 19th century was substantial, with the number of Norwegian citizens increasing from 883,000 in 1801 to approximately 2 million in 1900.[2] The century witnessed noticeable demographic changes, including a steady decline in overall mortality and a population growth driven by both migration and births. Notably, the cities in Norway underwent expansion in both geographic size and population. Trondheim, the focus of this thesis, expanded its city limits resulting in both more inhabitants being registered as living within its boundaries and more congregations being listed as part of the city.

During the period between 1830 and 1907, Trondheim stood as the third largest city in Norway. The city experienced economic growth through the export of fish, timber, and copper, along with growing mining, shipping, and shipbuilding industries. The city played a crucial role as a hub for goods entering and leaving the surrounding regions. Between 1830 and 1910, Trondheim's population surged from around 14,000 to approximately 46,000 inhabitants, mirroring the significant population growth in Norway as a whole.[3] The city experienced population growth due to a decrease in mortality rate and an increase in migration. Surprisingly, the birth rate did not rise sufficiently to account for the growth on its own. Therefore, migration and the expansion of city limits became the primary contributors to the increased population. The demographic change within the city forms the foundation of this thesis, as it aims to examine female mortality in the age group of 15 to 49, focusing

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[1] Schiøtz, A. (2003). *Folkets helse – landets styrke 1850-2003*. Universitetsforlaget. p. 35 – Literally" the health law"

[2] Backer, J.E. (1961). Dødeligheten og dens årsaker i Norge 1856-1955. (Samfunnsøkonomiske studier nr. 10). Statistisk sentralbyrå. p. 23.

[3] Sommerseth, H. L. (2023). What was Killing Babies in Trondheim? An Investigation of Infant Mortality Using Individual Level Cause of Death Data, 1830–1907. Historical Life Course Studies, 13, 61–88. https://doi.org/10.51964/ hlcs12290. p. 62.

specifically on maternal mortality and the causes of maternal death within the same age group in Trondheim between 1830 and 1907.

1.1 Thesis question

In the 19th century, the Norwegian government made efforts towards the reduction of the infant and maternal mortality rates. To achieve this objective, several measures were implemented. One such measure involved change midwifery into a more organized institution within the healthcare system. Additionally, maternity hospitals were established, and in the latter part of the century, efforts were made to provide proper education and training for future midwives. In 1810, Norway introduced a law mandating the establishment of a structured midwifery service. This was an important milestone for the profession as it became the first professional occupation available to women. The school of midwifery offered the first formal theoretical education specifically designed for women.[4] This effort on improving maternity care was also evident in Trondheim, although mostly through the effectivization of the midwife service. The establishment of maternity hospitals came at a much later period. A second important milestone came with the opening of the last will and testament of businessman and benefactor E.C. Dahl in 1882. In it he had allocated a substantial portion of his considerable fortune to establish a maternity hospital in Trondheim. However, it would not be until 1905 that construction could finally begin, and in 1908 the city's first maternity hospital opened its doors. Initially, the hospital primarily catered to the poorer part of the population. However, it didn't take long for all women to be included in the services provided by the hospital.[5] Considering all these factors, it leads us to the question of how female and maternal mortality rates were defined in Trondheim during the 19th century. Therefore, the central question of the thesis can be formulated as follows: **What characterizes the level and trends of maternal mortality during the 80 years prior to the opening of Trondheim's first maternity hospital?** The thesis also aims to explore the following subtopics:

1. How does the maternal mortality compare to the rate of total female mortality for women aged 15-49?

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[4] Kjærheim, K. (1987). *Mellom kloke koner og kvitkledde menn: Jordmorvesenet på 1800-talet*. Det Norske Samlaget. p. 7.

[5] Danielsen, R. (1997). *Trondheims historie 997-1997: 'En exempelløs fremgang' 1880-1920.* Universitetsforlaget. p. 318

2. What characterizes the maternal causes of death registration in Trondheim during the period 1830-1907?

1.2 Historical context

As previously established, Trondheim experienced substantial demographic changes during the 19th and early 20th centuries. The city had long been the administrative and religious centre of the northern part of Norway, while also being a regional centre of trade. Halfway through 1807, the city experienced a boom in the economy, based mostly on the export of fish and lumber.[6] The following decades also saw improvements in the public health infrastructure, and by the 1880s the city had systems for delivering clean drinking water directly into the inhabitants' homes. Public health was on the political agenda, and through the building of two public bathhouses the city wanted to improve personal hygiene. In the eastern part of the city there were reports of a stench which arose from the small, damp houses. This area was home to the poorer part of the population, where few had houses with direct access to water closets. Thus, the building of bathhouses was an attempt at improving the access to services that aimed to help with personal hygiene. The population grew more rapidly than most of the other big cities in Norway, except for Kristiania.[7] This growth was caused by the drop in deaths, the extension of the city limits, and an increase in migration to the city.[8]

In the 19th century the midwife service became more professionalized at the request of the Norwegian government. There was an interest in increasing the effort to reduce infant and maternal deaths, through both educating a larger number of midwives and building maternity hospitals.[9] However, as previously mentioned, the first hospital specialized in maternity care in Trondheim would not open until 1908. The early 1900s in Trondheim was characterized by

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[6] Mykland, K. (1996*). Trondheims Historie 997—1997: Fra Søgaden til Strandgaten 1800-1880*. Universitetsforlaget. p.37

[7] Sommerseth, H.L. & Walhout, E.C. (2021). The Gendering of Infectious Disease: Classifying Male and Female Causes of Death in the Netherlands and Norway, 1880-1910. *Social History of Medicine, Vol. 00*(0). 1-28. 10.1093/shm/hkab084. p. 7

[8] Mykland 1996:89.

[9] Sommerseth 2021:64

a focus on improving the city's health care services and saw enhancements in preventive measures.

2 Previous research

2.1 Maternal mortality

Maternal mortality represents female deaths which occur during pregnancy, childbirth, or the puerperium.[10] This category of mortality has often been referred to as deaths in childbirth, however it contains a larger group of deaths than just those of the mother during birth. According to Doctor Irvine Loudon the mother survived in 98% of deliveries in the 18th and 19th centuries. However, this does not automatically mean that few women died. At the end of the 19th century, the average number of deliveries in England and Wales was about 2000, meaning that as many as 40 women died of childbirth. Loudon uses the trend in England and Wales to illustrate maternal mortality and categorizes the mortality rates in to four 10-year periods, "1851-1860", "1891-1900", "1951-1960" and "1971-1980". During the first period, 1851-1860, the rate of maternal deaths per 10,000 births counts to 47, and 100 years later, in the period between 1951-1960, the rate is 5.6.[11] This results in a decline of 88.09%. This percentage averages to about 0.8% per year over the 100-year period. These numbers tell us that there was a significant decrease in the number of maternal deaths in England and Wales during this period.

A similar decline in maternal mortality can also be seen elsewhere. In 1985, Doctor Ulf Högberg wrote a doctoral dissertation about maternal death in Sweden between 1751 and 1980. Högbergs results indicate that the maternal mortality in Sweden declined from 900 to 6.6 per 100,000 live births during the 230-year period.[12] His conclusion states that an important reason for the decline in maternal mortality during the 230 years was the advancements made in medical technology, including antenatal and obstetric care, and family planning.[13] At the time of writing his dissertation, maternal mortality was one of the major

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[10] The period of adjustment after childbirth, which lasts six to eight weeks and ends with the first ovulation and normal menstruation. Britannica, T. Editors of Encyclopaedia (2017, July 5). *puerperium*. *Encyclopedia Britannica*. https://www.britannica.com/science/puerperium

[11] Loudon, I. (1993). Maternal Mortality: Definition and Secular Trends in England and Wales, 1850-1970. In K. Kiple (Ed.), The Cambridge World History of Human Disease (pp. 214-224). Cambridge: Cambridge University Press. doi:10.1017/CHOL9780521332866.025. p. 214

[12] Högberg, U. (1985). *Maternal Mortality in Sweden*. [Doctoral Dissertation]. Umea University. Diva-portal.org. http://www.diva-portal.org/smash/record.jsf?pid=diva2%3A142254&dswid=-8240 p.11

[13] Högberg 1985:5

causes of death among women in their reproductive years in the world. Högberg refers to a then current report in The US Department of Medical and Public Affairs medical journal, Series J, number 8, where it was estimated half a million women in the world died every year from complications of pregnancy, parturition[14], and puerperium. He does however say that this number is unreliable, stating that census and cause of death registration covers only a part of the world population. He further states that: "Socio-economic deprivation is described as the major factor underlying high maternal mortality".[15] The aims of his study were to "describe decline in the maternal mortality and its demographic impact", "explore predisposing, positive, risk factors of maternal mortality" and "characterize and estimate the potential impact of protective, negative, risk factors of maternal mortality". My thesis shares his aim of describing continuity and/or change in maternal mortality in an urban environment during the first part of the mortality transition, but besides this, Högbergs study covers a much broader view on maternal mortality in Sweden. This thesis aims to explore the maternal mortality in Trondheim between the early 19th and 20th centuries. The line will be drawn between 1830 and 1907, as this will be the base of discussion when analysing the population at risk of death. This, and more, will be explained in more detail later in the thesis. The line being drawn between these years is due to data availability, primarily baptism records prior to 1830 as basis for the denominator, and complete coverage of burial records after 1907. The results of Högbergs research recorded that almost 77,000 maternal deaths were registered in the Swedish national statistics between 1791 and 1900. In the beginning of the period Högberg researched, 10% of all female deaths between the ages of 15 and 49 years were maternal. That is a strong contrast to the 0.2% of maternal deaths at the end of the period.[16] Irvine Loudon identified a drop in maternal mortality from 47 to 5.6 per 10,000 births from 1851 to 1960, whereas Högberg identified a drop from 90 to 0.7 per 10,000 births from 1751 to 1980.[17] This indicates a similar drop in the maternal mortality between the two studies.

In 1961, Statistician Julie E. Backer wrote a report on the trend of mortality and causes of death in Norway during the period between 1856 and 1955. In the report, she included

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[14] Childbirth.

[15] Högberg 1985: 7.

[16] Högberg 1985:10

[17] Högbergs results originally used deaths per 100,000 births and has been adjusted to match Loudons calculation.

maternal mortality. Through a table in the report, she presented the maternal mortality per 10,000 births in the years 1900-1955. The data used in the table is narrowed down to females in the ages between 15 and 39. This differs from both mine and Ulf Högbergs parameter of age, which includes the ages 15-49. Backers' table has been recreated in Table 1.

Years	Age of mother		
	15-19	20-29	30-39
1899-1902	54,9	26,9	32,1
1909-1912	49,7	25,6	28,2
1919-1922	38,2	22,7	27,5
1931-1935	26,7	20,3	28,8
1936-1940	30,8	17,6	25,6
1941-1945	22,6	12	25,7
1946-1950	11,8	7,9	12,3
1951-1955	3,6	4,9	9,3

Table 1 Julie Backers' table on maternal mortality per 10,000 births in Norway, 1900-1955
Source: Backer 1961:149

As with Ulf Högbergs graph detailing maternal mortality in Sweden between 1751 and 1980, Backer found a decrease in the rate of maternal deaths over the course of the period. Backer identified the age group of 15-19 as the group with the highest rate of maternal deaths per births. All the groups experience a decrease in the rate of mortality, with the group "15-19" having the steepest decline and the group "30-3"9 having a "steadier" decline. Backer explains that the decline in the maternal mortality during the period of 1900 to 1955 was a result of an immense improvement in focus on hygiene and knowledge on hygienics. The healthcare provided to women during pregnancy and labour had improved drastically, causing a much larger percentage of women in Norway to give birth at hospitals than before. The general risk of complications during labour being drastically reduced due to modern medicine was also a contributing factor.[18] Maternal mortality does not take up more space in the report than this. In a different report discussing infant mortality, Backer illustrates the maternal mortality by age of mother per 10,000 births from 1900-1960. One can note the relatively high mortality of which mothers under the age of 20 had compared to the age group of 20-30 years.[19]

[18] Backer 1961:149

[19] Backer, J.E. & Aagenæs, Ø. (1966). *Dødelighet blant spedbarn i Norge 1901-1963.* (Samfunnsøkonomiske studier nr. 17). Statistisk sentralbyrå. p. 19

A study on the maternal mortality rates in Britain during the 19th and early 20th centuries show a mean rate of 5 per 1,000 live births during the period between 1800 and 1850, which translates to a rate of 50 per 10,000 live births. The article also details how during the period spanning from 1800 to 1950, maternal mortality served as a pivotal metric for evaluating the effectiveness of maternity services, prompting obstetricians to thoroughly examine its rates and implications. During the period it was challenging to define maternal death, with the article using the inclusion of those associated with spontaneous abortions as an example.[20] This has also proven to be a challenge in this thesis, especially when it comes to the method of calculating the maternal mortality rate. This method, which will be further detailed in the chapter titled "Method and data", uses live births as the denominator for the calculation. This means that stillbirths are not included. These have in varying degree been transcribed by volunteers, and there have been speculations of under-registration of stillborn children, making them an unreliable source for calculating the rate of maternal mortality. One aim of my thesis study is to compare my own discoveries to those made by other researchers and commenting on the difference in mortality. Additionally, my study will expand on previous studies with the use of individual level causes of death where the main aim is to understand which complications of birth led to the most deaths.

Building upon this, it is imperative to acknowledge the contributions of Professor Ignaz Semmelweis, who pioneered the identification of the mode of transmission of puerperal sepsis. Semmelweis made a significant discovery that the occurrence of puerperal fever could be greatly reduced by implementing hand disinfection in obstetrical clinics and is often described as the "saviour of mothers".[21] As this thesis' subtopics include analysing the cause-specific maternal mortality, it would be surprising if zero cases of puerperal fever/sepsis were to show up in the funeral records for Trondheim 1830-1907. Professor Semmelweis worked at two obstetrical clinics in Vienna, of which the first clinic exhibited an average maternal mortality rate of approximately 10% caused by puerperal fever, while the second clinic experienced significantly lower rates, averaging less than 4%. The main difference between

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[20] Chamberlain G. (2006). British maternal mortality in the 19th and early 20th centuries. *Journal of the Royal Society of Medicine, 99*(11), 559–563. https://doi.org/10.1177/014107680609901113

[21] Ataman, A. D., Vatanoğlu-Lutz, E. E., & Yıldırım, G. (2013). Medicine in stamps-Ignaz Semmelweis and Puerperal Fever. *Journal of the Turkish German Gynecological Association, 14*(1), 35–39. https://doi.org/10.5152/jtgga.2013.08 p.35

the two clinics were the personnel, with the first clinic being used as a teaching service for medical students, and the second having been selected for the instruction of midwives only. The reputation of the first clinic being riskier for women was widely known, and some women even chose to give birth in the streets and pretend it was a spontaneous birth, making them eligible for the childcare benefits of the clinics. Surprisingly, there were less cases of puerperal fever for women who gave birth outside than in the clinics, making Semmelweis question if the techniques used were the issue. He even went as far as removing religious practices to see if these played part in the higher numbers of puerperal sepsis. In his search for an answer, he stumbled upon an explanation. Following the death of a friend who had been poked by a student's scalpel during an autopsy, Semmelweis discovered a similar pathology in his friend and the women who died of puerperal fever.[22] Based on his observations, he reached the conclusion that both he and the medical students inadvertently transferred "cadaverous particles" on their hands from the autopsy room to the patients they examined in the First Obstetrical Clinic. This finding helped explain why the midwives in the Second Clinic, who were not involved in autopsies and had no exposure to cadavers, experienced a significantly lower mortality rate. In continuation of this discovery, Semmelweis instituted a policy of using a solution of chlorinated lime for washing hands after post-mortem examinations. This resulted in the mortality rate declining by 90%, proving that washing hands drastically reduced the cases of puerperal fever. After presenting his findings to the medical community, his ideas were rejected, as some doctors were offended by the accusation of having unclean hands. Despite this, Semmelweis widened the scope of his washing protocol in 1848 and documented all future cases of puerperal fever.[23]

2.2 Fertile and maternal age

The base of this thesis is the aforementioned dataset, comprised of digitized funeral records. Seeing as the thesis wants to answer the question on the extent of maternal mortality in Trondheim from 1830-1907, we must first define maternity. One way of doing this is using the term fertile age, and explaining what this term bases itself on. Both Ulf Högberg and Julie Backer use a defined period of fertile age for the women they study, the former using the ages 15-49 and the latter using the ages 15-39. This thesis will use the same definition as

[22] Ataman et.al. 2013:36

[23] Ataman et.al. 2013:37

Högbergs, 15-49. The reasoning for this grouping of women is based on the most used definition on at what time women are considered to be of fertile age. Many studies find a correlation between aging and fertility, with adverse outcomes. One study, done by Jeffrey Klein, MD, and Mark V. Sauer, MD, claims that: "Reproductive capacity in women declines dramatically beyond the fourth decade of life."[24] The article discusses fertility in women of advanced reproductive age, and studies infertility in different age ranges, e.g., 30-39. The study concludes with the impact of aging on the female reproductive tract being significant. Klein and Sauer claim that fertility begins its decline at an as early age as the mid-20s and keeps falling significantly through the late 30s and 40s. They end their paper by stating that: "Age, however, remains an important independent predictor of success…" when discussing fertility among women of advanced maternal age.[25] This implies that women of older ages will have more difficulty becoming pregnant, which strengthens the parameter of a fertile age period of 15-49. This brings us on to another important term, maternal age.

Maternal age is the term for the age of the mother at the time of delivery. In an article on the maternal and perinatal outcomes of advanced maternal age, Doctor Pooja Sharma of the Department of Obstetrics and Gynaecology at K.J. Somaiya Hospital in Mumbai, India, defines women who give birth under the age of 19 as young mothers, and women who give birth over the age of 35 as older mothers, i.e., women of advanced maternal age. Doctor Sharma herself admits to the fact that the definition of advanced maternal age varies from study to study, where some of the earlier reports fixes the cut-off points at 35 years and the more recent ones around 40 years. Sharma goes on to explain that advanced maternal age, i.e., women aged 35 years and older at the time of childbirth, have an increased risk of adverse maternal and perinatal outcomes. These outcomes include postpartum haemorrhage and eclampsia, as well as adverse infantile outcomes including preterm birth, low birth weight and neonatal mortality.[26]

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[24] Klein, J. & Sauer, M.V. (2001). Assessing fertility in women of advanced reproductive age. *American journal of Obstetrics and Gynecology, 185*(3). 758-770. https://doi.org/10.1067/mob.2001.114689. Abstract.

[25] Klein & Sauer 2001:765

[26] Sharma, P. (2023). Advanced maternal age: maternal and perinatal outcomes. *International Journal of Reproduction, Contraception, Obstetrics and Gynecology, 12*(4). 1133-1139. https://doi.org/10.18203/2320-1770.ijrcog20230827. p. 1133-1134.

Sharma is not alone in stating these increased risks of advanced maternal age. In 2012, Professor Mary Carolan of the School of Nursing and Midwifery at Victoria University in Melbourne, Australia, wrote an article on advanced maternal age and maternal and perinatal outcomes. The article was written as a review based on the background of an increase in fertility options for women aged ≥45 years. Carolan's findings included:

> (1) increased rates of stillbirth, perinatal death, preterm birth and low birth weight among women ≥45 years. (2) increased rates of pre-existing hypertension and pregnancy complications such as GDM, gestational hypertension (GH), pre-eclampsia and interventions such as caesarean section; and (3) a trend of favourable outcomes, even at extremely advanced maternal age (50–65 years), for healthy women who had been screened to exclude pre-existing disease.[27]

This shows that research into advanced maternal age has provided findings which include both adverse and favourable outcomes. Carolan concludes with the association between advanced maternal age and adverse maternal and perinatal outcomes, although the absolute rate of stillbirth/perinatal death remains low. In this thesis I will not be able to determine the age-specific risk in maternal mortality, but I will discuss the distribution of maternal deaths by age groups and see this in relation to age specific fertility.

2.3 Maternity care in the 19th and 20th centuries

In 2021, Andreas Kotsadam, Jo Throi Lind and Jørgen Modalsli wrote a research paper on health personnel and mortality in Norway during 1887-1920. Their paper explores the importance of public health investments in the period, and one of their conclusions is that midwifery reduced maternal mortality in rural areas.[28] As well as this, they specify that they found no signs of medical doctors decreasing the mortality in this period, and add that through the increased access to midwives, maternal mortality was subject to a 62% reduction. Later in this chapter, and the chapter detailing the analysis of the results, we will look at the enhanced focus on reducing stillbirths and maternal death, and Kotsadam et al. find that the public investment in social programs had substantial effects on human welfare. As well as

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[27] Carolan, M. (2013). Maternal age ≥45 years and maternal and perinatal outcomes: A review of the evidence. Midwifery, 29(5), 479–489. https://doi.org/10.1016/j.midw.2012.04.001. Abstract.

[28] Kotsadam, A., Lind, J.T. & Modalsli, J. Call the midwife. Health personnel and mortality in Norway 1887–1920. *Cliometrica 16*, 243–276 (2021). https://doi.org/10.1007/s11698-021-00230-9. Abstract

this, the researchers attribute the increased knowledge of hygiene and the use of antiseptic methods as reasons for the decrease.[29]

In 1810, Norway passed a law which demanded that the midwife service in the country had to become professionally organized. The law required the Norwegian institution of birth to become more professionalized. This might have been a request of the government to reduce the number of unassisted home births, therefore reducing the infant and maternal mortality. Before this law, most births occurred at home, where the only help women received was from the priesthood and uneducated midwives. The latter tried their best to make the mother as comfortable as they could during labour, but they had no official medical training. Forthcoming, for the sake of consistency, these uneducated caregivers will be referred to as birth wives. The new law required maternity care to be formalized and professionalized. Midwifery was the first profession open to women, and the school of midwifery was the first school to offer a formal, theoretically based education for women.[30]

Historically there has always been a need for maternal healthcare, and traditionally this care was given by birth wives with no formal education. Because of the lack of education, and the fact that the work was unorganized, there is no way of knowing who they were and how they were chosen to help. However, it was preferred that these women were widowed, and that they themselves had given birth. In her book *Mellom kloke koner og kvitekledde menn*, Kristina Kjærheim quotes the Danish physician Thomas Bartolin, who in 1664 wrote that "she must be so strong and old, that she can endure exertion, and she must have given birth herself and be a widow".[31] To be able to separate maternity care as a standalone practice, there had to be a certain population basis and financial surplus. The first birth wives in Norway were based in Bergen towards the end of the 16th century, and only families in the upper classes could afford the help. However, what knowledge did these caregivers possess to be able to help? In the 16th, 17th and 18th centuries, medical literature on births was often translated to Danish, and of these most were based on maternity care of old.[32] There is also an indication that these books were only available to priests and local doctors. This indicates that

[29] Kotsadam et al. 2021:263

[30] Kjærheim 1987: 7

[31] Kjærheim 1987: 17-18

[32] Kjærheim 1987: 18

the birth wives had little access to medicinal literature. That said, in the time before the 19th century there was no clear line between folk medicine and scientific medicine. In connection to this, it is difficult to state if the birth wives would have been better equipped to do their job if they had access to such literature.[33]

Having a functioning midwife service was of high importance. In the book *"Den haarde dyst" Fødsler og fødselshjelp gjennom 150 år,* Historian Ida Blom talks on the subject of midwifery in Norway. In the book Blom illustrates through a diagram the drop in deaths during childbirth through 1856-1980.[34] This drop is something we will look back on during the analysis of the data extracted from the funeral records in Trondheim. Historically, maternity care in Norway runs deep with other European countries, and one often sees more similar care across countries than one sees from town to town in the same country.[35] As previously stated, the midwife service was codified by law in 1810. When the law was passed, there were 50 registered educated midwives. These women were tasked with educating new midwives, and the start of the Norwegian midwife service began. Even though the basis of monopolizing this service was thin, the plans for a public midwife service were successful. By 1860 Norway was divided into midwife districts, and in 1908 the midwives organized a union, with over 1300 midwives.[36]

Blom also wrote about birth and maternity care in Norway. The book focuses on home births and births in institutions, and how births with the assistance of a midwife differs from those without. In the list of contents, she has named the chapters by the various ways of giving birth through history, starting with home births assisted by a birth wife. Within the chapter she explains ways of protecting the labouring mother. More folk-like interpretations surrounding maternity care was that the goals were to bring forth a healthy and viable child and that the mother was cared for before, during and after the birth. Both the child and the mother were at risk of harm. Traditionally the thought was that the risk of harm could be a result of external factors, or even the behaviour of the mother. It was feared external threats were those of God

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[33] Kjærheim 1987: 19

[34] Blom, I. (1988). *«Den haarde dyst»: Fødsler og fødselshjelp gjennom 150 år*. J.W. Cappelens forlag. p. 11.

[35] Blom 1988:19

[36] Kjærheim 1987: 24

or other powers. When a mother gave birth to a deformed child, it was thought that the child had been swapped by evil powers and that fate had it willed.[37] The mother was given full responsibility of keeping herself and the child safe, and many of the measures made for a safe birth were of superstitious nature, in contrast to the healthcare system in Norway which has this responsibility today. The entire situation of home births with the assistance of a birth wife was a system based on the experience women had gathered through generations of births. This system of giving birth was one of three systems that lived side by side in Trondheim, among other places. The systems were: homebirth assisted by a birth wife, homebirth assisted by a midwife, and the emerging institutionalized birth deliveries.[38]

During the period this study covers, women in Trondheim had to rely on the system of home births assisted by birth wives and midwives. Through the 1860 Public Health Act comprehensive data on the annual count of medical doctors, midwives, dentists, and vaccinators were collected for all Norwegian cities and rural areas. In Trondheim, as estimated by the 1865 population census, there were 10 midwives available, equating to one midwife per 550 women aged 18–49. It is worth noting that this data corresponds to the period covered by the study. However, by 1910 (three years after the conclusion of this study), the number of midwives had tripled, resulting in a ratio of one midwife for every 430 women aged 18–49 in Trondheim.[39]

Regarding the third system, one of the institutions that helped women during birth was E.C. Dahls foundation. The institution didn't revolutionize maternity care and was inspired by similar foundations already existing in other European countries. The oldest European institutions aimed at helping poor unmarried women who were given free maternity care if they agreed to training in said maternity care.[40] But why Trondheim? The establishment of the first institution in Scandinavia dates back to 1775, which positions E.C. Dahl's foundation as a relatively belated addition to the academic landscape. However, despite being late, the foundation was founded as a result of increased focus on maternity care. The city wanted to

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[37] Blom, 1988: 37

[38] Korsvold, T. (2001). *Sykehusfødselen tar form – med en nærstudie av E.C. Dahls Stiftelse.* Abstrakt forlag. p. 78.

[39] Sommerseth 2023:64

[40] Korsvold 2001: 79.

fight poverty, and the care of which women giving birth received was part of the motivation for an improved system. Fighting both infant and maternal mortality was on the agenda, and creating the foundation was a way of doing just that.[41]

[41] Korsvold 2001: 85.

3 Method and data

3.1 Quantitative Method

This thesis is based on a demographic quantitative method used to answer the thesis question. The statistics made to analyse and answer the thesis question is based on data gathered from a dataset of deaths in Trondheim from 1801 to 1933. The analysis uses data from the church books in Trondheim during the period and is extracted from the Norwegian Historical Population Register. The data has been closely examined and reviewed before made into statistics and has been specified to be used in this thesis' search for maternal deaths. The church books and funeral records have been transcribed by volunteers and professional transcribers at the Norwegian Centre for Historical Data (NHDC). The data has been prepared for analysis through Microsoft Access 2016 by the NHDC. My contribution was examining the listed cause of death originally found in the funeral records and looking for any deaths related to maternal mortality then coding them using the historical version of the International Classification of Diseases version 10 (ICD-10h). The method used is therefore quantitative, i.e., statistical analysis, which is a method of analysis based on numbers and statistics. This method of historical study can be perceived as synonymous with statistics; however, statistics is only one way of working quantitative. Statistics as an academic discipline is relatively new, with it being integrated into demographic studies of the state as late as the 17th century. This addition meant that mathematics became more commonly used in the quantitative method, and after the incorporation of computer science in the 1960s, the singular quantitative method was replaced. Now the understanding of the quantitative method as only being statistics has been split into two: quantitative approaches and quantitative methods as two separate understandings. Quantitative method is the backbone of almost all demographic studies.[42]

Using the dataset, I will make statistics in the form of tables and graphs to illustrate the levels and changes in female and maternal mortality. These will then be the basis for analysis of causes of maternal death. Microsoft Access 2016 has been used because of its ability to handle the raw data in the form of a database, and the flexibility to construct new categories to the dataset. The data has then been made into statistics using Excel 2016. The spreadsheet

[42] Solli, A. (2018). Å arbeide kvantitativt. In Melve, L. & Ryymin, T. (ed.), *Historikerens arbeidsmåter*. (p.92-121). Universitetsforlaget. p. 93.

program has been used as it also is a product made by Microsoft, making it easier to export data between the two programs. The dataset is already divided into 10 categories:

Name of category:	**Explanation:**
id_ori	Person id-number
dyear_use	Death year
DODSARSAK_original	Cause of death as registered in the funeral records
causeofdeath_short	Short text version of the original cause of death
DODSARSAK_flag	Refers to funerals where the cause of death was compiled from the ministerial copy book (klokkerboka)
cod_literal	Standardized cause of death
icd10	Cause of death coded using standard ICD-10
icd10_desc	Description of cause of death from ICD-10
icd10h	Cause of death coded using ICD-10h, a specific version of ICD-10 made for historical causes of death
icd10h_description_EN	English description of cause of death from ICD-10h
Maternal_death	Cases related to maternal death are marked with “x”.

Table 2 List detailing categories used in the dataset in Microsoft Access

In addition to the already plotted in categories, I have made a category specifically used to identify maternal deaths. The category is named “Maternal_death”, where all deaths of a maternal cause are marked with “x”. This makes limiting the results to only maternal deaths much easier. After doing this, I make Access search for deaths in the category “Pregnancy, childbirth and the puerperium” in ICD-10. To find these I use a set of keywords and phrases specifically used to describe maternal deaths, whom will be detailed later in the subchapter titled “Searching for cases of maternal mortality”.

3.1.1 ICD-10h

ICD (International Classification of Diseases) is a system of classification used in 117 countries to diagnose diseases and causes of death. Healthcare workers in Norway use this system for classifying causes of death in the country and use the codes when reporting to the national register. ICD is owned and managed by WHO, and Norway is slowly converting from ICD-10 to the new version, ICD-11.[43] In the dataset used in this thesis, the deaths are also coded by ICD-10h. This version is a system built on ICD-10 and is used for the coding of historical causes of death. ICD-10h was developed by a collaborative project between several European scientists called SHiP.[44] "SHiP is a network of European researchers studying mortality dynamics in port cities across Europe in the 19th and 20th centuries."[45]

DODSARSAK_original	causesofdeath_short	cod_literal	icd10	icd10_desc	ICD10h
Cirrhosis hepatis, Eclampsi	Cirrhosis hepatis, Eclampsia potatorum		O15	Eclampsia|Eclampsia	O15.000
Ecclampsia, Molden?? cere	Ecclampsia, Molden?? cerebr		O15	Eclampsia|Eclampsia	O15.000
Eecampsia potatorum	Eecampsia potatorum	eclampsia xxx	O15	Eclampsia|Eclampsia	O15.000
Vitia organ cerebri med Ee	Vitia organ cerebri med Eeclampsia	vitia organ cereb	O15	Eclampsia|Eclampsia	O15.000
Eclampsia	Eclampsia		O15.9	Eclampsia, unspecifi	O15.900
Barselkrampe	Barselkrampe	barselkrampe	O15.9	Eclampsia | Eclampsi	O15.900
Barselkrampe	Barselkrampe	barselkrampe	O15.9	Eclampsia | Eclampsi	O15.900
Barselkrampe	Barselkrampe	barselkrampe	O15.9	Eclampsia | Eclampsi	O15.900
Barselkrampe	Barselkrampe	barselkrampe	O15.9	Eclampsia | Eclampsi	O15.900

Figure 1 Illustration of the dataset containing the digitalized funeral records.

Source: The Norwegian Historical Data centre, UiT The Arctic University of Norway, Historical population register for Norway, [Funeral records, Bakkelandet parish, Domkirken parish, Ila parish and Vår Frue parish 1830-1907]. Original sources in Arkivverket

Figure 1 illustrates some of the categories used in the dataset comprised of the digitized funeral records. The illustration only covers some of the categories used to identify and code the deaths, as all categories have been explained earlier in this chapter. Presented in the columns named ICD-10 and ICD-10h we see some of the codes used to classify the cause of death. These are characterized by the combination of letters and numbers. The letter represents a main chapter in ICD-10, in this case chapter O represents all deaths related to pregnancy, childbirth and the puerperium. The numbers after the letter represent the subchapters, and as we can see the codes O15.000 and O15.900 belong to the same

[43] Direktoratet for e-helse. (u.å.). *ICD-10 og ICD-11*. E-helse. https://www.ehelse.no/kodeverk-og-terminologi/ICD-10%20og%20ICD-11

[44] Studying the History of Health in Port Cities

[45] Janssens, A. (2021). Constructing SHiP and an International Historical Coding System for Causes of Death. *Historical Life Course Studies*, 10, 64-70. https://doi.org/10.51964/hlcs9569. Abstract.

subchapter. These are different causes of death in the subchapter, and often differentiate between specifics of time of death.

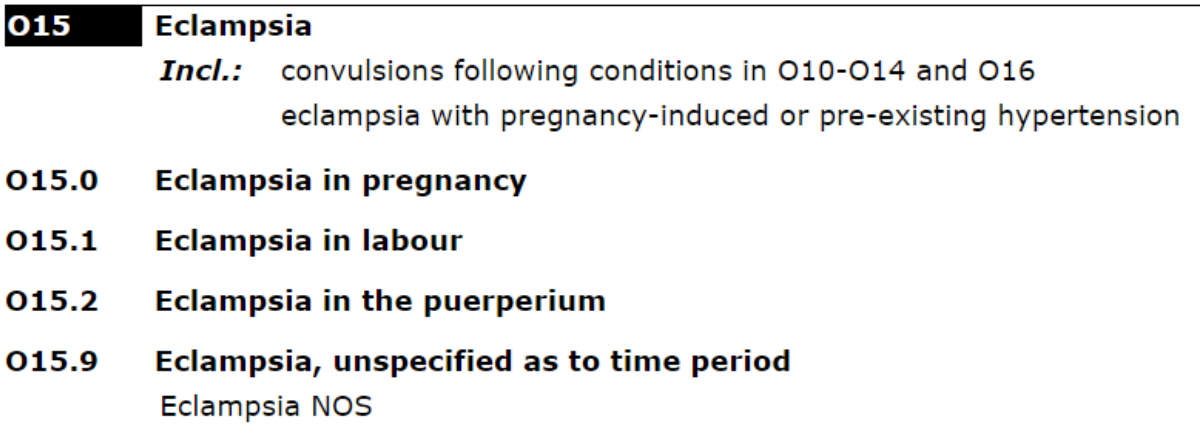

Figure 2 Illustration of the ICD-10 classification system, English description

Source: World Health Organization 2016[46]

In Figure 2 we see the English explanation to the codes found in ICD-10. The difference between ICD-10 and ICD-10h is the numbers after the dot. In ICD-10h there has been added two more numbers after the dot, making it possible to group the historical causes of death not listed in the modern ICD-10. One example of this is the code for puerperal sepsis, which in ICD-10 is O85, but in ICD-10h is O85.001. This makes the historical terms used for cause of death more specified in the system of classification.

3.1.2 Calculating mortality and population at risk

To analyse the numbers of maternal death we must make them into rates, as this provides a better method of comparison to previous research. To do this I will calculate both the female mortality for women aged 15-49 and the maternal mortality for women aged 15-49. These will however be calculated using different denominators. The numerator will be the number of deaths found in the dataset. The denominator will be calculated in two different ways. Firstly, when analysing the total female mortality rate, we will use the censuses done during the 19th and early 20th century. These were not done each year but spread out over the course of the period in question, in 1801, 1865, 1875, 1885, 1891, 1900 and 1910. To produce yearly mortality rates, we must calculate the average population growth between the censuses, so

[46] World Health Organization. (2016). *ICD-10 Version:2016*. Retrieved 26.4.2023 from https://icd.who.int/browse10/2016/en#/O10-O16

that we have a number for each year between 1830 and 1907. This will give us the yearly population at risk of death. As previously explained, the thesis uses women aged 15-49 as a parameter for the population at risk. Secondly, when calculating and analysing the maternal mortality per year and per 5-year periods, we will use the registered live births for the same period. As previously mentioned, women experienced an increased risk of maternal death during the first and last part of their fertile age. As such, we should ideally construct age-specific mortality rates, where the number of deaths of women in for example the age group "15-2"4 is divided by the number of births given by women in the same age group. However, we do not have this information linked to the database yet.

Instead, this thesis will calculate 5-year period maternal mortality rates for the age group of 15-49. By using the numbers of births instead of women who were under risk of dying, we will have a more accurate denominator for calculating the actual mortality of maternity. This is because the births represent a specific number of women who were at actual risk of dying a maternal death. There is however a group which is not represented; women who gave birth to a stillborn child. If we were to use the censuses, we would be including every woman aged 15-49 alive during the period, many of whom might not have given birth during this period of their life, or even at all. Additionally, twin births are counted twice in the denominator, but should be changed to one. On the other hand, since twin births was relatively rare, we do not believe that this will alter the results significantly.

To calculate a total rate of mortality for all women between 1830 and 1907, we need to calculate a number to represent the population at risk for each year in that period. To do this we must fill in the "blank" years between the censuses. This can be done in two ways. The first is based on a linear interpolation, meaning that the growth is even and uninterrupted and viewed in absolute numbers. In his book *Historisk Demografi: Ei innføring i metodane,* Ståle Dyrvik uses the population growth in Bø in Telemark as an example. In 1769 the populace amounted to 2061, and in 1801 it amounted to 3024. This means that in 32 years the populace increased by 963. Dyrvik then calculates what the average growth would be from 1769 to 1772 by dividing this growth by the number of months between 1769 and 1801, which gives him the number 2.55. This is the average monthly growth in populace. Between the 15th of August 1769 and the 1st of July 1772 there were 34.5 months, making the equation 2.55*34.5, resulting in 88. He then adds 88 to 2061, which results in the approximate populace in 1772 being 2149. Linear interpolation assumes a linear relationship between the data points and

may not accurately represent non-linear trends in the data. This method is most useful when the variation between the known data points is relatively small.

The other method is done by using geometric interpolation. Geometric interpolation assumes a geometric relationship between the data points and is suitable for data that exhibits exponential or multiplicative growth or decay. It is important to note that geometric interpolation may not accurately represent data with non-geometric trends or when the common ratio assumption is not valid. In geometric interpolation, one assumes that the growth between two points in time (e.g., from 1769 to 1801) has progressed smoothly, expressed as a percentage rate. The calculations made for finding the approximate populace in Trondheim during the years 1801-1910 is done by using the latter method. We make an estimate on the yearly growth between the years of the censuses. This method makes an average number for the decrease and increase in population between two reference points, which in turn is an average of mortality, migration, births, and relocations. This method does not account for large yearly variations, which are not visible as each year will have an equal amount of increase or decrease in population.[47] Geometric interpolation has limitations in that it cannot account for the annual fluctuations caused by factors such as epidemic years. Another aspect that this method fails to consider is that a 20-year-old in 1865 would be 30 years old in 1875. This means that the method does not track cohorts over time but rather examines the relationship between the number of 20-year-olds in 1865 and 1875. We also need the number of live births to represent the denominator when calculating the maternal mortality. These are gathered from the baptism registers recorded by the priests in the city's parishes, during the period between 1830 and 1907, resulting in 50,461 baptisms. The denominator for the maternal mortality will therefore be the yearly number of births.

3.2 Searching for cases of maternal mortality

When searching for maternal deaths in the dataset, certain terms and phrases are used. These phrases are represented in the table below, which lists the standardized version of the phrase, as well as an English translation. Each phrase has numerous ways of spelling, which was handled by using truncation in the Access query. The phrases are generated from first identifying individual causes of maternal death, and what phrases are used in the original description of the cause. They are then later standardized to gather as many cases as possible.

[47] Dyrvik, S. (1983). *Historisk Demografi: Ei Innføring I Metodane*. Universitetsforlaget. p.54

They did however often fall victim to shortenings, such as “Forlø” and “puerp”, among others. This was done to identify any cases of misspelling in the description of the cause of death. The variable of misspelling will be described in the chapter on source criticism, as language used to describe the cause of death often varied from case to case. In addition to this, as a way of guaranteeing the identification of each maternal death, the dataset has also been manually searched and coded.

Norwegian term (standardized)	**English translation**
Barselseng	Maternity bed
Barselkrampe	Puerperal cramps (eclampsia)
Barselfeber	Puerperal fever
Forløsning	Delivery
Nedkomst	Birth
Gravid	Pregnant
Barsel	Maternity
Puerperal	Puerperal
Puerperalis	Puerperalis
Abort	Abortion
Partum/partus	Partum/partus
Barn/børn	Child

Table 3 List of keywords used in the search for maternal deaths, Norwegian terms in alphabetical order.

The Norwegian Historical Data centre, UiT The Arctic University of Norway, Historical population register for Norway, [Funeral records, Bakkelandet parish, Domkirken parish, Ila parish and Vår Frue parish 1830-1907]. Original sources in Arkivverket

When used, the term “barselseng” signifies that the subject undoubtedly died during or after childbirth. Among many cases where the term is used, a second cause is also listed, for example “mavebetændels efter barselseng, 7 dage etter nedkomst” (inflammation of the stomach after “maternity bed”, 7 days after birth). This is interesting, as medical statistics

doesn't usually list several causes or underlying causes of death. When looking through one of the primary sources and searching for any cases of multiple causes to further explain the use of "barselseng" as a cause of death, something interesting comes up. In the report on women dying in "maternity bed", the doctor specifies that he does not know the specific cause of death, since the women didn't receive medical attention.[48] This could result in the doctor using an underlying condition as well as listing "barselseng", the general term used when identifying cause of maternal death, as both being the cause of death. The information provided above regarding two causes of death tells us that the woman died from an inflammatory disease in her abdomen, seven days after giving birth.

In an article discussing how many women died during pregnancy, researchers state that the most cases of maternal death in developing countries happen due to haemorrhaging and high blood pressure. These account for half of all maternal deaths.[49] Bearing this in mind, the women who died from "barselseng", likely died from haemorrhaging and/or high blood pressure. It is important to note that one cannot compare 19th and 20th century Norway to a modern developing country. However, if one had limited access to medical equipment during childbirth in the 1800s and 1900s in Trondheim, it is not unthinkable that the mother was at a greater risk of bleeding out during or shortly after giving birth. This does not mean every cause of death was due to bleeding, just that statistically it is more likely they died from this than other causes. Using the keyword "forblød" [50] when searching in the database gives us a result of three deaths. Only two of these are related to maternal death. One of them details that the woman died of haemorrhaging during the birth of a set of twins. The records go on to say that a girl was born and lived, and that the other child died, gender unknown. Given the detailing we can confirm that the death was maternal. The second result only describes the cause of death as haemorrhaging during childbirth, but because the age listed for the woman is 27, we can safely presume that this was a case of maternal mortality. The third case which

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[48] Norges officielle statistic (NOS). (1855). Beretning om Sunhedstilstanden og Medicinalforholdene I Norge 1855. [Report on health and medical situation in Norway 1855]. Statistisk sentralbyrå. https://www.ssb.no/a/histstat/div/is/is_90.pdf. p. 44.

[49] Jentoft, S., Nielsen, V.O. & Roll-Hansen, D. (2011). Hvor mange kvinner dør i svangerskap? Samfunnsspeilet/Statistisk sentralbyrå, 2011(2). s.74-81. https://www.ssb.no/a/samfunnsspeilet/utg/201102/ssp.pdf. p.80

[50] "To bleed out."

shows up is described as a stroke, most likely due to internal bleeding, i.e., not a case of maternal death. To identify that the resulting cases from using the keywords are in fact maternal deaths and not infant deaths, we look at the listed age at death.

When looking for specific cases of maternal mortality, keywords like “forløsning” and “nedkomst” (including different truncations) were somewhat productive. In total, when using these keywords, 85 cases come up, i.e., 27% of the total amount of maternal deaths found in the dataset. The keywords roughly translate to birth, and are synonyms to the Norwegian word for childbirth, “fødsel”. However, direct usage of the word “fødsel” produces 156 cases, of which only one is related to maternal death. The rest are cases of infantile death, ranging from children dying right after birth, to children dying from other diseases where the priest has added information related to the child’s birth. The latter is present in the dataset, for example “Født i 10de Md. ved Vending og Udtakn. Ethvert Livstegn svandt snart efter Fødselen”. This roughly translates to “Born at 10 months through external cephalic version and extraction. Any sign of life faded soon after birth.”. These variations in explaining cause of death are to be expected, seeing as the 38,444 cases vary from the year 1801 to 1933. This does however make it more of a challenge to find all the cases of maternal mortality in the dataset, but this is also what makes this study interesting. The variations are human, they are a result of personal preference and contemporary events and standards. Such variations are to be expected when the human factor plays a part in the describing of cause of death. However, seeing as this study focuses on mothers, it is important to remember exactly who the individuals are. The dataset consists of 38,444 deaths, but these are women and men of all ages, and all causes of death. Seeing as this thesis will focus on women who die during or shortly after childbirth, this number will be significantly lower. This brings us to the previously explained term “fertile age”.

When analysing the data, only deaths related to fertile age are of interest. That data will be discussed in the chapter that deals with source verification. By using this definition, the study not only narrows down the number of cases, but also makes the results more manageable. However, as seen in Backer’s research, a large amount of the maternal deaths occurred in the group of women under the age of 20. By looking at the table she is referring to one can see that between the years 1931-1935 26,7 out of 10,000 births resulted in death in the age group

15-19.[51] When looking at the causes of death that Backer lists in the same period, 27 out of 10,000 births resulted in death of the mother.[52] This means that the younger age groups were more at risk of death when giving birth. It might be difficult to understand how 53 deaths of puerperal fever, 28 deaths of eclampsia and 39 deaths of other pregnancy and maternity related diseases adds up to a total of 27 deaths per 10,000 births. Adding these deaths up you get a total of 120 deaths, as seen in its respective category. If you divide 120 deaths by 43,833 women at risk of death and multiply the sum with 10,000 you end up with 27.37 (120/43,833*10,000). It is also possible to simply state that 120 out of 43,833 women died, however by analysing the results through a rate they are more comparable to other studies.

The use of mortality as a way of explaining the severity of a cause of death, in this case maternal deaths, is based on calculating how many people died and dividing it by how many people could have died. This shows how widespread the cause of death is. Table 3 consists of the search words primarily used to identify and gather maternal deaths in the dataset. Other terms and phrases were also used, however mostly to either separate cases of infant mortality from the cases of maternal mortality, or to weed out any cases not related at all to maternity. However, one term that surprisingly gave 0 cases of maternal death was the term "svangerskap".[53] This term only resulted in cases of infant mortality. There is an obvious correlation between maternal and infant mortality, which is also evident in the dataset. Searching for the term "dødfødt"[54], after narrowing down the cases by using the category of "x" in the column for "maternal_death", results in 16 cases of maternal death. There may be even more, as "dødfødt" exactly as it is spelled might be one of many ways of spelling the term, which is something that will be discussed in the chapter on source criticism.

3.3 Primary sources

3.3.1 Church books

The object of the church books was originally the registering of the demographic information within a congregation, but over the course of the 1800s they were increasingly used for population statistics on a national level. This change was a result of the Norwegian state

[51] Backer 1966: 19

[52] Backer, 1966: 18

[53] *Pregnancy*

[54] *Stillborn*

needing the information for demographic purposes, which is reflected by the creation of SSB (Statistics Norway) in 1876.[55] The church books were kept by the priests and provided an overview of sacred events such as baptisms, marriages, and burials. The funeral columns used in this thesis are, age (up until 1877), date of birth (from 1877), sex, date of death, and cause of death. The church books used covers deaths in the period between 1830 and 1907, and the churches responsible for burials in Trondheim were Nidaros Cathedral, and the churches Vår Frue, Bakkelandet, and Ilen. Bakkelandet and Ilen churches were included later than Nidaros Cathedral and Vår Frue church, as they only became part of Trondheim because of the expansion of the city's borders in 1863 and 1879.

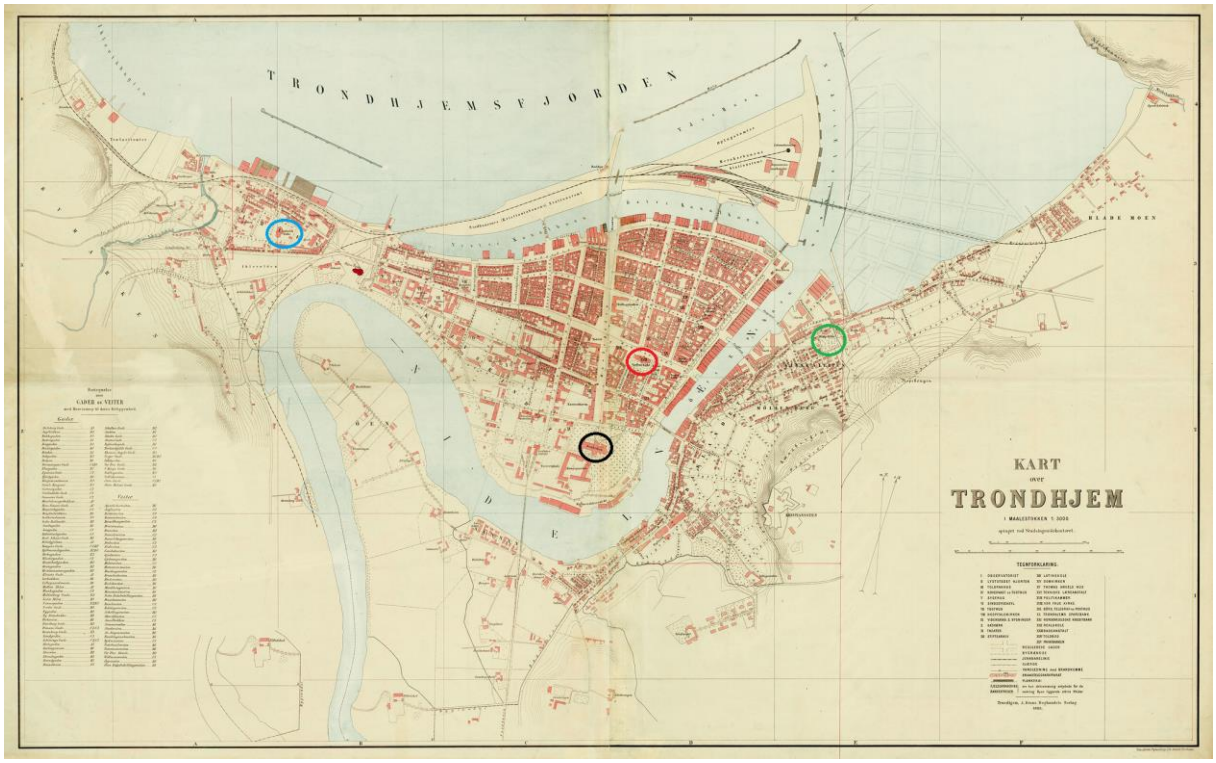

Figure 3 Digitalized map of Trondheim in 1883, made by Adelsteen Knudsens Forlag

Source: Adelsteen Knudsens Forlag, Owned by Trondheim city archive
https://www.flickr.com/photos/trondheim_byarkiv/49208087747/in/album-72157626502678846/

[55] Stoltz, G., Hofman, E., Berg, L.P. & Aspøy, A. (2021, 13. May). Statistisk sentralbyrå. *Store Norske Leksikon*. https://snl.no/Statistisk_sentralbyr%C3%A5_-_SSB

Figure 3 is a digitalized map of Trondheim in 1883. I have marked the churches with circles on the map: The black circle marks Nidaros Cathedral, the red circle marks Vår Frue church, the green circle marks Bakkelandet church, and the blue circle marks Ilen church.

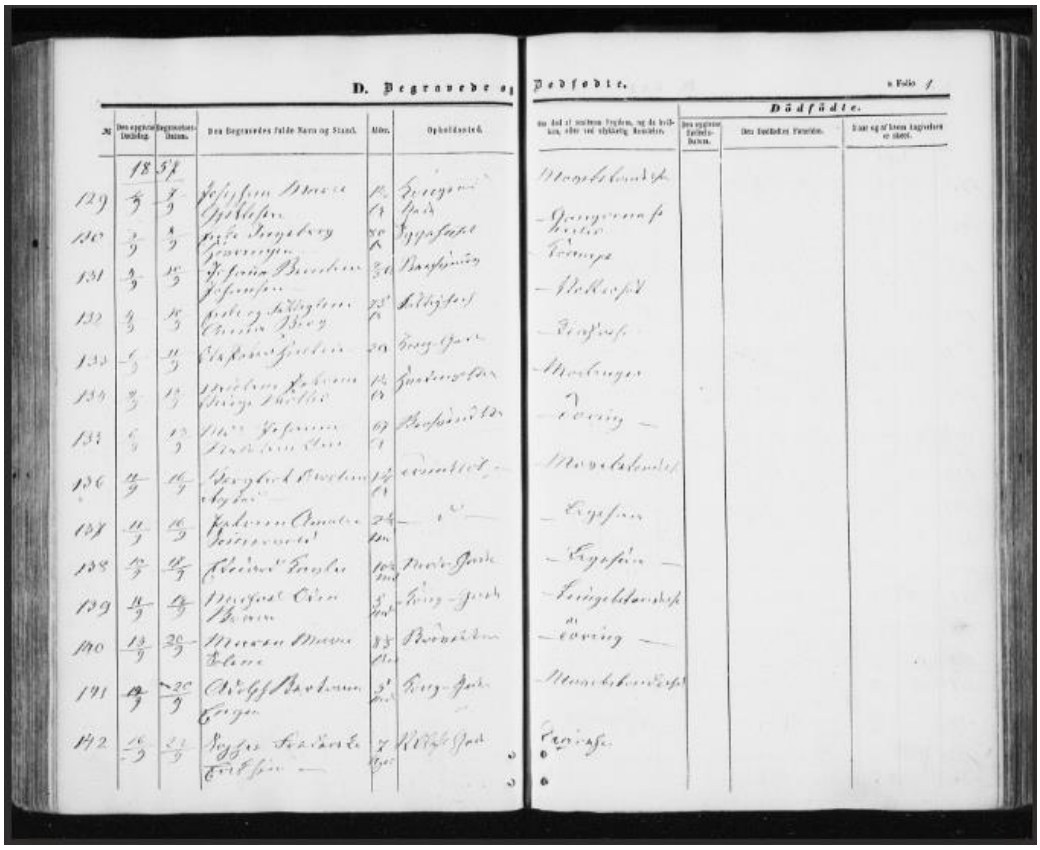

Figure 4 Page from the church book for Nidaros Cathedral, 1857, Trondheim.

Source: Digitalarkivet, Ministerialbok nr. 601A21, 1857-1865, p. 1

Figure 4 is a digital copy of a scan of one of the pages in a church book from Trondheim. The pages show how the information on each person is divided into columns. From left to right the columns inform the reader on date of death, date of burial, full name and occupation, place of residence, and cause of death by contagious disease or accident. The information we are looking for is the date of death, age at death, sex, and cause of death, as these are the variables used in this thesis. The year of death is important for the analysis, as it opens the possibility to show changes in the rate of mortality over time, which will be detailed further in the chapter "Results and analysis".

3.3.2 Censuses

The population growth over the span of the years between 1830 and 1907 is an essential part of the analysis, as it gives us the basis of comparison when explaining the maternal mortality

in the same period. Knowing the people at risk, i.e., women between the ages of 15 and 49 years, makes it possible to create rates of female mortality. To identify the women at risk we need to look at both the censuses done and birth records, of which the method of gathering has been explained in the chapter detailing the method used in this thesis. The censuses give us a true illustration of the population in the years they were done. They do however only give us a moments glance of the characteristics of the populace during the years the censuses were done, and tell us nothing about any demographic, social, economic, or scientific changes happening during the period.

Another source of information on the censuses are the books *Trondheims Historie 997-1997: Fra Søgaden til Strandgaten 1800-1880*, written by Knut Mykland and *Trondheims Historie 997-1997: 'En exempelløs fremgang' 1880-1920*, written by Rolf Danielsen. In his book, Mykland details the rich history of Trondheim between 1800 and 1880. Among these details he speaks on the population growth, which surprisingly was a product of low birth numbers, combined with an increase in migration and a decline in deaths.[56] This source gives us a more direct and personal testimony of Trondheim's history, a testimony we won't be able to find in the censuses. The same can be said for Danielsen's book. In his chapter on population and business life, he details a population growth of 18.5% during the period between 1901 and 1910, a decrease from the growth of 30.9% in the period between 1891 and 1900. The increase in population was a result of just over twice as many births as deaths, with the number of births totalling 13,258, and the number of deaths totalling 6,627.[57] However, the decrease in population growth between 1901 and 1910 was a consequence of the declining economy in the city, resulting in an increase in emigration to other municipalities. The emigration between 1901 and 1910 resulted in 3018 citizens leaving the city. Women of fertile age could most likely be represented in this group. However, this did not cause a decrease in the population, as the number of births and immigrants totalled a growth of 7153 individuals. This means that the population increased with 3540 more citizens than it decreased.[58]

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[56] Mykland 1996:88

[57] Double of which is 13,254.

[58] Danielsen 1997:277.

3.3.3 Reports on state of health

One set of the primary sources for this thesis is a collection of health statistics for the general state of health in Norway. The yearly printed reports informed the reader of the general health statistics of the entire country and the main counties. The reports are not used as a primary source for this thesis, as they inform the reader on more than maternal health. The medical statistics will however be used as a comparison to the funeral records. The first report on the general health was made in 1845, and is extremely poor in information, compared to the later versions. Since this thesis focuses on maternal mortality in Trondheim, the part of the statistics which discusses "Søndre Trondhjems amt", which translates to southern Trondheim County, is of interest. Specifically, we are searching for cases of maternal death in "Trondhjems kjøbstad". In the statistics of 1845, "maternity" is mentioned only once, and in a somewhat confusing manner:

> "Also, this year took precedence in a disadvantageous manner in the form of an amount of peculiar and somewhat unfortunate births; thus died the third birth wife undelivered and a fourth of typhus, 14 days after a troublesome birth". … [forovrigt udmærkede det hele Aar sig ligesaa ufordelagtigt som paafaldende ved en Mængde besværlige og tildels uheldige Fødsler ; saaledes døde 3de Barselkoner uforloste og en 4de af Typhus, 14 Dage efter en meget besværlig Fødsel.] [59]

Where there are no mentions of "barselseng" or any other related causes of maternal death, the deaths happened in other areas than Trondheim. The quote above gives us little information on the maternal health in Trondheim in 1845. However, it does show that maternal health was on the agenda, and as we will come to see in the later versions, maternal deaths were listed in tables to give a better look at maternal health in the counties. As far as I am able, I interpret this as three women dying undelivered, and a fourth dying of typhus. Whether the fourth woman died prenatal, during birth or postnatal is impossible to say, as there is no information on this specific case. Since these reports aren't the basis of this thesis, and as they will only be used as a comparison to the funeral records, I have made the choice to only look at the reports between 1853 and 1863. They do however give us the opportunity

[59] Norges officielle statistic (NOS). (1887). Beretning om Sunhedstilstanden og Medicinalforholdene I Norge I Aaret 1845. [Report on health and medical situation in Norway 1845]. Det Steenske Bogtrykkeri. https://www.ssb.no/a/histstat/div/is/is_111.pdf p. 22

to somewhat cross-reference the funeral records. This is based on the two sources being produced by different authors, with the main difference being that the funeral records were recorded by the priests, and the reports were written by doctors. This makes it possible to compare the registration, or lack thereof, by the two occupations.

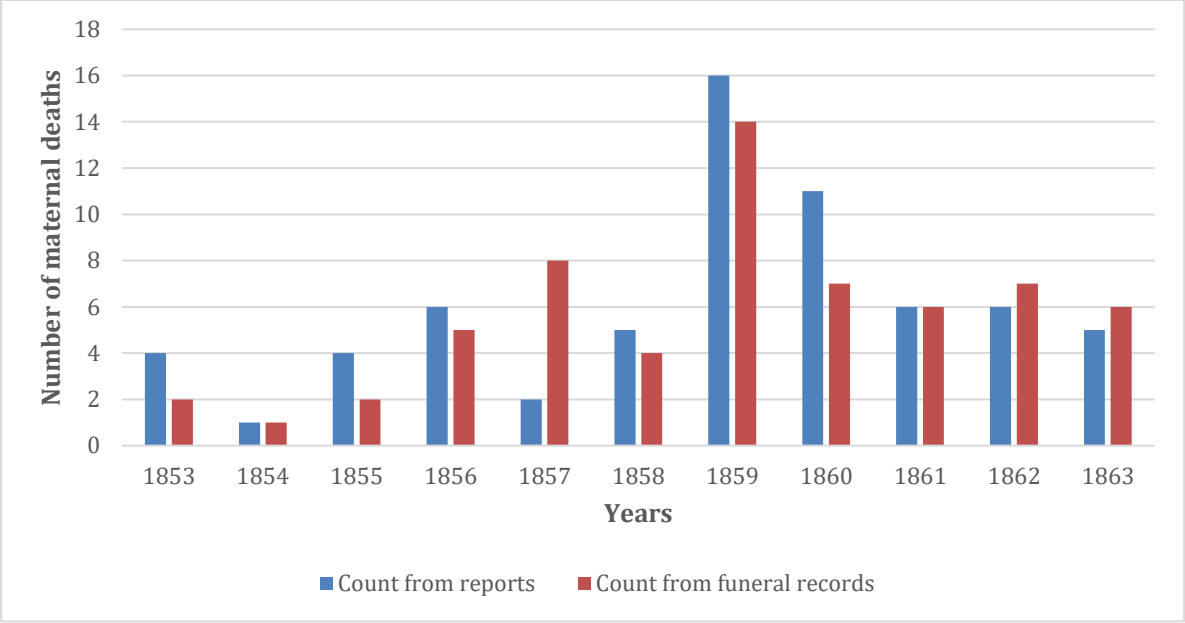

Figure 5 Maternal deaths gathered from reports on state of health for Søndre Trondhjem Amt, compared to maternal deaths gathered from the funeral records gathered from churches in Trondheim

Sources: The Norwegian Historical Data centre, UiT The Arctic University of Norway, Historical population register for Norway, [Funeral records, Bakkelandet parish, Domkirken parish, Ila parish and Vår Frue parish 1830-1907]. Original sources in Arkivverket

NOS. Report on health and medical situation in Norway 1853;1854;1855;1856;1860;1861a;1861b;1863a;1863b;1864;1865

As we can see, the numbers are somewhat similar, with over/under-reporting from either of the institution in all the years, except from 1854 and 1861. The main difference can be seen in 1857 where the funeral records list 6 more cases of maternal death than the reports, and 1860 where the reports list 4 more cases than the funeral records. What could have caused such a difference in the registration of maternal deaths? And does this make one source more credible than the other? Did doctors report fewer cases of maternal death in fear of damaging their reputation? From 1862 onwards in Trondheim, medical death certificates were issued and collected by the priests to register cause of death in their funeral records. This could indicate that the registration of cause of death before 1862 was less accurate, as the cause of death recorded at often times was provided by the midwife, priest, non-medical personnel,

and/or medical practitioners.[60] This change in registration practice could have resulted in a more accurate registration of the cause of death, which is somewhat visible in Figure 5, as the numbers from both 1862 and 1863 differ in value by 1. When searching for cases of maternal death in the report from 1857, the report lists cases of puerperal fever in the county, and mentions 9 cases in Trondheim, 4 in Strinden and Selbo, as well as 1 in Røros. Of these 14, 6 had fatal outcomes. However, the report fails to specify where these deaths took place. The fatal cases have not been included in the statistics for that year, as we cannot be sure they happened in Trondheim.[61] The report from 1857 is not the only one which fails to specify location of death, making the collection of data from the reports somewhat challenging. However, they do list obstetric operations, where they specify which cases had fatal outcomes. As well as this, from 1858 onward the reports also include a table detailing the mortality in the county, with a row for Trondheim and a column for deaths in "barselseng".[62] However, in the detailing of the obstetric operations done in the county, they do not specify which part of the county they took place, making them ineligible for inclusion in the cases collected from the reports. This makes only the table detailing the mortality in the county eligible for use. Considering the increased compliance between the medical reports and church books, we can assume that the analysis of the data from 1862 onward will be more accurate.

3.4 Source criticism

Being critical of the sources one uses is a basic part of historical research. The "art" of source criticism has however been subject to change. In the beginning, during the 19th century, source criticism relied heavily on the view of separating the witness with the reality and doing so using said criticism to gain access to the objective truth. In hindsight, it is not that simple. During the 1950s and 60s, this view on the subject was met with, ironically, much criticism. The thought that any source written by a historian, or any other civil servants, would be inherently objective was no longer the case. Does not the author of a source make his or her

[60] Sommerseth 2023:69

[61] Norges officielle statistic (NOS). (1860). Beretning om Sunhedstilstanden og Medicinalforholdene I Norge 1857. [Report on health and medical situation in Norway 1857]. Den Kongelige Regjerings Departement for det indre. https://www.ssb.no/a/histstat/div/is/is_92.pdf p.77

[62] Literally «maternity bed»

own subjective choices of what is important?[63] Note that the sources used in this thesis are over 150 years old and not specifically made with the intention of historical study of the trend in causes of death. That being said, the registering of population statistics most likely came from a desire to do demographic research, however the use in historical analysis is most likely a by-product. One example of this is the church books, which were used to register all sacred events and not to research and analyse the trend in causes of death over time.

3.4.1 Church books

When analysing the dataset, it is important to remember the human element which comes into play. The variations that occur might alter the results of the study, and it is important to be critical of what one reads. The dataset used in this study has been digitally transferred from funeral records, and some of the information might have been lost in translation. You see this occur when there are question marks in the description of the cause of death. Examples of this are "Faldt ned i en stamp med kogende vand og døde hen ?? ??", which translates to "fell down in a tub of boiling water and died ?? ??", or "For tidlig Fødsel.??" which translates to "Premature birth. ??". When transcribing nominative censuses, there are specific protocols that must be followed. One such protocol is the standard for transcribing church books, which was introduced in 2005 by the Norwegian Digital Archive. Since then, the Archive has been stringent in approving any transcriptions of the church books. This standard, known as KYRRE, provides instructions on how to transcribe using tools like Excel or the registration application called August.[64] In addition to KYRRE, the Norwegian Historical Data Centre employs another standard called Histform. Histform provides guidelines and instructions for formatting and transcribing census data in Norway. One of the instructions in this standard is to use two question marks (??) when the transcriber is unable to decipher the written text.[65] Therefore, in the previously mentioned case of the woman who died due to premature birth, some of the information was lost in translation. This lack of information might alter the results of the study, so it is important to keep this in mind as a source critical moment. This is

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[63] Melve, L. (2018). Kildekritikk – en kort historikk. I Melve, L. & Ryymin, T. (ed.), *Historikerens arbeidsmåter*. Universitetsforlaget. p. 36-39.

[64] Digitalarkivet. (w/o year). *Kyrre-standarden*. Digitalarkivet.no. https://www.digitalarkivet.no/content/guidelines-kyrre

[65] The Norwegian Historical Data Centre. (w/o year). *Histform*. Rhd.uit.no. https://rhd.uit.no/histform/histform.html.

always the case in historical sources, and as important in this study as any. The priests and doctors who tended to their patients might have had subjective views that could play a part in their diagnostic work.

A general point of source criticism for the church books is the fact that we won't have access to all baptisms, marriages, and funeral records. Even though the recording of church books became required by law in 1687, many priests were late to start up this practice. Additionally, many of the records have been lost, and the writings are sometimes unreadable. There were individual differences in how records were kept, with only some standards of compiling the information. Maybe some of the priests were unsystematic when recording the information and forgot to write down crucial details about certain individuals, particularly children and the poor. The reliability on the information the priests were given can also be questioned. And even after all this, the reliability of the primary sources can fall at the last step, the digitalization and transcription of the information.[66]

The lack of a cause of death is also an aspect of source criticism for the church books and resulting dataset. Of the 3980 cases of death of women aged 15-49 found in the dataset, 139 of these were registered without a cause of death. This challenges the preciseness of the results in the study, as we can't know for sure that we have taken account for all maternal deaths in Trondheim during the period between 1830 and 1907. The results won't be accurately representative for the populace at the time. Cases of maternal death could hide behind wrongly registered causes of death, and there is an argument to be made of the professional integrity of doctors. The previously mentioned change in registration practice could also play part, as this altered the registration of cause of death in the funeral records. The larger question is if the change improved the registration of the cause of death with the implementation of death certificates, compared to the previous system without any official certificates, somewhat based on retellings from family members of a person's cause of death. We cannot say for sure how common it was for relatives to report a cause of death in the cities, however this is an aspect of source criticism. There could have been an underlying fear of being viewed as a "bad" physician if one had a high rate of death for one's practice. This could lead to the lack of registering, or registering the cause of death as something the doctor

[66] Thorvaldsen, G. (1996). *Håndbok i registrering og bruk av historiske persondata*. Tano Aschehoug. p.86.

had no chance in fighting. Some evidence of this can be found in the response Ignaz Semmelweis received for his report on the significance of clean hands when treating patients, as his methods were rejected based on some of the doctors being insulted by the insinuation that they had "unclean" hands.[67] In addition to this, in chapter 3.2 I mentioned cases where two causes of death were listed. Within this there are also cases where the woman died of a cause not directly related to maternity, where the doctor has also listed the woman as pregnant: "Tarm & ventricullar Catarrh med debilitet. Graviditet 7de Maaned".[68] This case has been included as a case of maternal death, but there is a point for source criticism present, as the cause of death was intestinal catarrh, and not something more directly related to maternity. The death has been coded as O75.900, "Complications of labour and delivery, unspecified", but if the doctor/priest had not detailed her being 7 months pregnant, the case would not have been noticed and included in the study. In addition to such cases, there are the cases where the cause of death could be related to maternity, where they have not been included because of the lack of information. Examples of these cases are the cases where the listed cause of death is a form of ruptured uterus. There are three cases with this cause of death listed, one of which has been included in the study as it is described as "Ruptura uteri partus", with partus most likely describing the death as occurring during childbirth. The other two cases are only listed as "Ruptura uteri" and "Rupterius uteri", and the lack of detailing in what situation the rupture occurred makes it so that we can't include them in the study. These cases, and others, are examples of cases where the registering of maternal deaths most likely suffers from underreporting.

3.4.2 Position of infection theory

In the 19th century, there was a significant advancement in the understanding of infection, particularly in Norway. During this time, the prevailing belief among most Norwegian doctors was in support of the infection theory attributing the spread of diseases to the presence of miasma.[69] This theory of infection bases itself on an understanding of contagion based on the spread of particles called miasma. Without being tied to any specific disease, the particles would produce sickness in a person, and were theorized to have a distinct smell but were themselves naked to the eye. The theory dominated the position of theory of infection

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[67] Ataman et.al. 2013:37

[68] Intestinal and ventricular catarrh with debility. 7 months pregnant.

[69] Moseng, O.G. (2003). *Ansvaret for undersåttenes helse 1603-1850.* Universitetsforlaget. p. 305

during the 1800s. However, in the late 1840s to 1860s, doctors started to theorize contagion by direct transfer between one person and another. The theory stated that this transfer was of bacteria of a specific disease, which unsurprisingly was challenged by the doctors in support of the non-specific miasma particles.[70] The switch in position of theory of infection is an aspect of source criticism, as the change will have increased knowledge of e.g., symptoms of puerperal fever, causing a reduction in deaths classified as "barselseng". Consequently, it will be interesting to determine whether we can identify this alteration via the analysis of specific causes of maternal death.

3.4.3 Keywords and terms

One challenge that plays part in the accuracy of the statistics is the difference in terminology used by the priests when writing down the cause of death in church books and burial registers. Some of the words used in the cause of death are outdated, in the sense that they are not used in the ICD-10. "Barselseng", (directly translated to "maternity bed"), falls under this list. If one considers the frequency of the use of the word, it can be argued that it is used as a description of time and location of death, as in the individual died in childbirth. Knowing this one can draw the conclusion that the cause of death was unknown, however most likely due to childbirth. It would be coded as O75.9, "complication of labour and delivery, unspecified". The Norwegian Academic Dictionary defines "barselseng" as: "Seng som kvinne ligger i når hun føder (og en tid etter fødselen)".[71][72] In an article studying maternity care in an intercultural and historic perspective, the authors write that birth posed a real threat for both mother and child, and that the risk of dying in "barselseng" was high. During the period between 1866-1900, 9% of deaths among women of fertile age in Norway were deaths in childbirth.[73]

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[70] Skålevåg, S.A. (2021, 23. november). Miasme. In *Store norske leksikon*. Retrieved 25/4-2023 from https://snl.no/miasme.

[71] Det Norske Akademis Ordbok. (w/o year). Barselseng. In *Det Norske Akademis Ordbok*. Retrieved 28.4.2023 from https://naob.no/ordbok/barselseng

[72] The bed in which a woman lies when giving birth (and for some time after the birth).

[73] Eberhard-Gran, M., Nordhagen, R., Heiberg, E., Bergsjø, P. & Eskild, A. (2003). Barselomsorg I et tverrkulturelt og historisk perspektiv. In *Tidsskr Nor Lægeforen 2003,123.* 3553-6. https://tidsskriftet.no/2003/12/fodselshjelp-og-barselomsorg/barselomsorg-i-et-tverrkulturelt-og-historisk-perspektiv

3.4.4 Censuses

One aspect of source criticism regarding the censuses is the registration of age or birth date. In the nominative censuses done in 1801 and 1865, age on the upcoming birthday was registered. In the censuses done in 1875 and 1891 the year of birth was registered, in the census in 1900 both year and date were registered, and lastly for the census done in 1910 date of birth was registered.[74] This brings the question of how accurate the registration of age was, seeing as the calculation of age is more accurate for the census done in 1910 than the others. There is also the possibility of people wrongfully reporting their age by rounding it to end with 0 or 5, specifically for the censuses done in 1801 and 1865. This is a phenomenon called heaping, which still occurs in countries with a poor system of registering its citizens demographic information. This has been found to have happened in Troms County in the 19th century, with an overrepresentation of citizens aged 30 year or older.[75] Another method of age reporting is proxy reporting. Proxy reporting is a method used in research and surveys to collect information about individuals when direct self-reporting is not possible or reliable. It involves obtaining data from someone who has knowledge or is closely associated with the person in question. In the context of age reporting, proxy reporting refers to relying on second-hand reports from family members, caregivers, or other informants to determine an individual's age.[76] As a solution to this challenge, I have merged the ages into 5-year age groups between the ages 15-49.

3.4.5 Reports on state of health

As opposed to the church books that were written by priests, the reports on the state of health were written by doctors. The reports consist of quantitative data, making them subject to the same source critical aspects as the church books. The data could have typing errors, and the wrong cause of death could be listed. As well as this, the printed reports were retellings of other doctors' reports, which could cause the subjective inclusion and exclusion of information. Some of the information represented in the reports was also influenced by the records provided by the priests, as they at often were present at a death where a doctor had not been called. This means that the priest recorded the cause of death, before reporting back to

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[74] Thorvaldsen 1996:63

[75] Thorvaldsen 1996:64-65

[76] Cobb, C. (2018). Proxy reporting. In Vannette, D.L. & Krosnick, J.A. (eds.) *The Palgrave Handbok of Survey Research*. (427-437). Springer International Publishing.

the doctors.[77] This is however not the case for the entire period, as previously explained with the change in registration practice implemented in 1862.[78] And as previously mentioned, when the doctor didn't know the cause of death it was often because the patient did not seek medical attention. This further emphasises that the same source critical aspects applied to the church books must be applied to the reports on the state of health in the country.

[77] Sommerseth 2021:1097.

[78] Sommerseth 2023:69

4 Results and analysis

4.1 Total mortality

This thesis aims to examine female mortality, and when using the parameter of "women aged 15-49" to narrow down the result, the total number of deaths in the dataset is reduced to 3,908. The next parameter is women whose cause of death relates to maternal mortality, i.e., anything from ectopic pregnancies to puerperal pneumonia. When implementing this, the number is reduced to 314, i.e., 8 % of all deaths among women in age group 15-49. As previously explained, the maternal deaths will be used as the numerator in the fraction when calculating the rate of maternal mortality. In this group of 314 women, the youngest and oldest are 17 and 48 years of age, which fits perfectly within the parameter of fertile age.

When analysing the data, I will use 5-year periods for both the period between 1830 and 1907, as well as for grouping the ages of the women. This will provide a more robust result for analysis. I will also look at the total female mortality rate as a comparison to the maternal mortality. This is done to understand the impact maternal mortality had on the populace in Trondheim.

Range	Pop at risk	Live births	Female deaths age 15-49	Female mortality age 15-49	Maternal death age 15-49	Maternal Mortality age 15-49
1830-34	17,940	1,246	66	3.7	6	4.8
1835-39	19,052	1,539	182	9.5	10	6.5
1840-44	20,244	1,644	148	7.3	11	6.7
1845-49	21,520	1,700	162	7.5	10	5.9
1850-54	22,889	2,108	178	7.8	17	8.1
1855-59	24,355	2,531	197	8.1	33	13.0
1860-64	25,929	2,697	187	7.2	35	13.0
1865-69	27,712	3,147	241	8.7	33	10.5
1870-74	29,994	3,250	283	9.4	32	9.8
1875-79	32,185	3,737	362	11.2	26	7.0
1880-84	33,302	3,713	349	10.5	18	4.8
1885-89	37,917	3,517	363	9.6	24	6.8
1890-94	51,315	4,126	367	7.2	22	5.3
1895-99	53,624	5,195	350	6.5	15	2.9
1900-04	56,121	6,498	348	6.2	20	3.1
1905-07*	36,014	3,813	197	5.5	2	0.5

Table 4 Description of data, Trondheim 1830-1907.

Source: The Norwegian Historical Data centre, UiT The Arctic University of Norway, Historical population register for Norway, [Funeral records, Bakkelandet parish, Domkirken parish, Ila parish and Vår Frue parish 1830-1907] [Census, Trondheim city, 1801, 1865, 1875, 1886, 1891, 1900, 1910]. Original sources in Arkivverket
** The final period includes only three years*

Table 4 consists of all the data used to produce the graphs detailing the changes in female and maternal mortality. The estimated yearly growth is represented in the graph below.

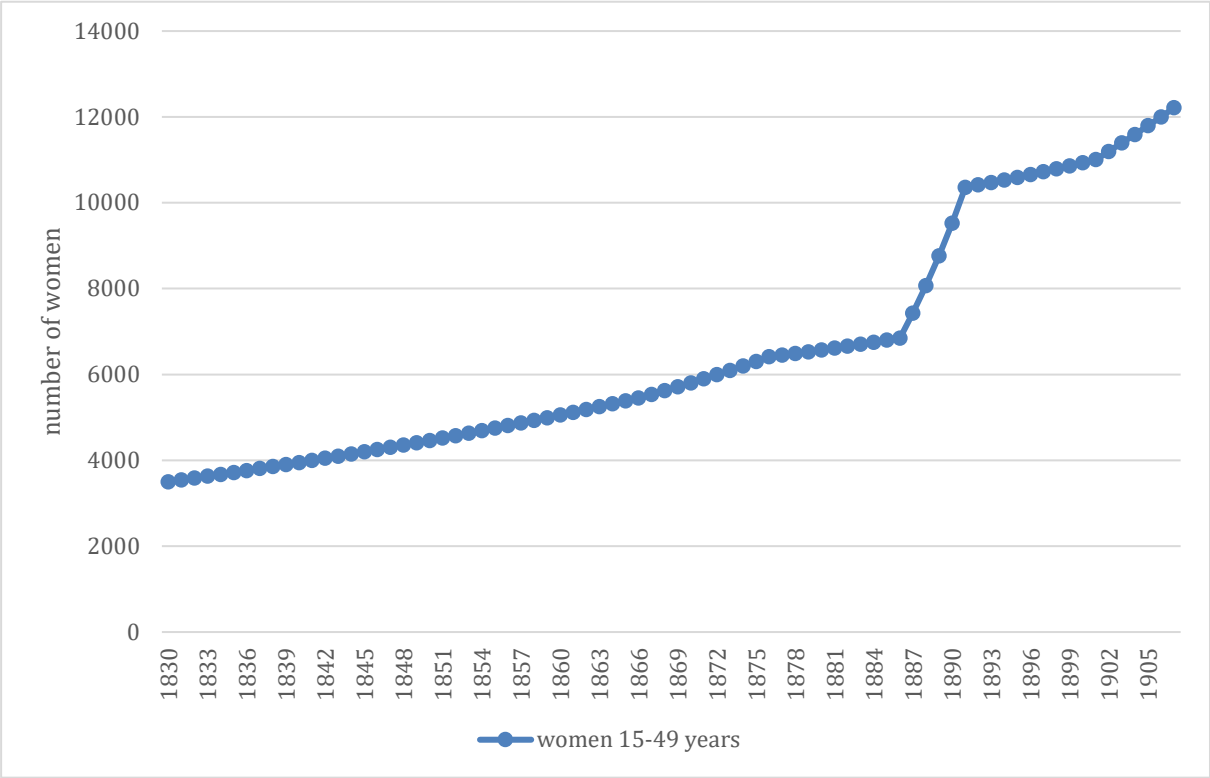

Figure 6 Annual population growth 1830-1907, by women aged 15-49 in Trondheim

Source: The Norwegian Historical Data centre, UiT The Arctic University of Norway, Historical population register for Norway, [Census, Trondheim city, 1801, 1865, 1875, 1886, 1891, 1900, 1910]. Original sources in Arkivverket

The line presents the annual growth of women aged 15-49 between 1830-1907 in Trondheim based on geometric interpolation for the intercensal years. Since the censuses following the 1801 census were all conducted during the last month of the year, each census represents the population on January 1st the following year. There is a slight flattening of the annual growth curve between the two censuses of 1875 and 1885, and a significant growth between the 1885 and 1891 censuses. One would expect the line to keep its original incline, and if we look at the point of "1901", the line somewhat returns to this original increase. What happened in the years between 1876 and 1885 that made the growth in populace almost stagnate, to then increase drastically from 1891 to 1901? There were censuses in 1875, 1885, 1891 and 1900, and these are used to calculate the estimated annual growth or decline in the population. Since the trajectory of the line changes between these years, something must have happened to alter the actual counts, making the estimates change.

This change might have been caused by the increase in the migration from Norway to the USA. In Norway, historians divide the migration into two waves, the first lasting from 1825 to 1865 and the second from 1865 to 1914. The first wave is described as primarily being a

migration of whole families, which totalled in about 80,000 individuals. The second wave was dominated by individuals, not groups, and was mostly comprised of younger people. After 1870 one also witnessed a larger base of migration based on labour, or the lack of it.[79] This might explain the flattening of the curve between 1875 and 1885 in the population growth in Figure 6, seeing as the second wave of migration from Norway occurred during the same period. Next, we must ask what happened in 1891 that caused the formidable growth in the populace. One explanation might be the expansion of the city limits. In her article on infant mortality in Trondheim, Professor Hilde Leikny Sommerseth details this increase in the population.

> A number of extensions to the city boundaries contributed to this increase. The two greatest extensions took place in 1864 and 1893. The first of these extended the city borders in the east, and about 2,000 individuals were added to the city's population.[80]

In the extension in 1893, the city limits were stretched even further east, but also south and west. This extension altered which area of the city was most densely populated, with the eastern area going from being populated by 13% in 1845 to 56% by 1900.

In the analysis of the data, I have decided to make groups of 5 years between 1830-1907. The last group will only contain the years 1905-1907. The reason for this is that we lack accurate information on the number of live births after 1907 for the calculation of maternal mortality. It is of worth to note that all women, regardless of marital status, are included. Next, we must establish the denominator. Starting off with the total number of female deaths, we must use the dataset of all deaths of women aged 15-49.

As we can see in Figure 7, the rate of total female mortality starts relatively low in the period between 1830 and 1834, before increasing drastically to a rate of 9.6 per 1,000 women aged 15-49 between 1835 and 1839. The rate then drops to 7.3 between 1840-45, before steadying itself for approximately 20 years. In the years between 1865 and 1879 the rate increases to a peak of 11.2 before its continuous decline from 1880 onward.

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[79] Amblie, S. (2016). Migrasjon og arkiv. Migrasjon i Norge fra 1800-tallet til i dag og dokumentasjonen i arkivene. *Tidsskriftet Arkiv, 7*. https://doi.org/10.7577/ta.1668

[80] Sommerseth 2023:62

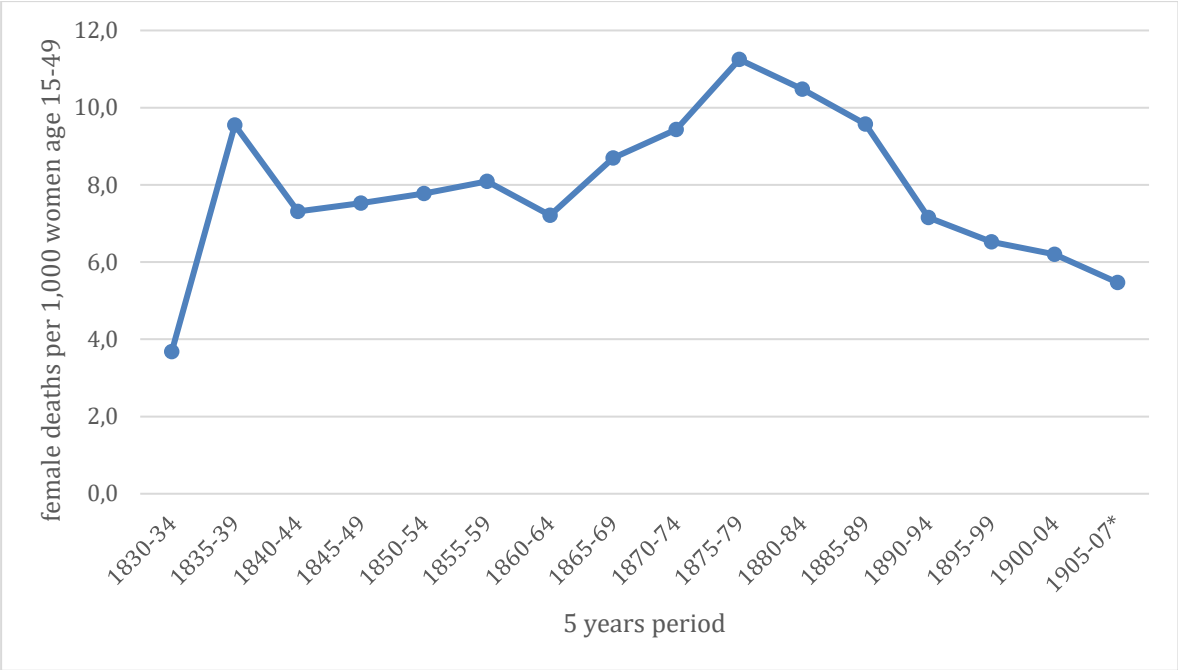

Figure 7 Graph of mortality rate of total death of women aged 15-49, Trondheim 1830-1907

Source: The Norwegian Historical Data centre, UiT The Arctic University of Norway, Historical population register for Norway, [Funeral records, Bakkelandet parish, Domkirken parish, Ila parish and Vår Frue parish 1830-1907]. Original sources in Arkivverket

The Norwegian Institute of Public Health (FHI) state that the 19th century in Norway was characterized by an increase in the general private economy, better hygiene, and better nutrition. Towards the end of the 1800s the microbe was discovered, which opened the door to preventative measures for the spread of disease. This is shown in the steady improvement in the public health, and a decrease in the number of infections. This could be a part of the explanation of the decline in total female mortality in Trondheim from 1880 and onwards.

4.2 Maternal mortality

Now that we have identified the total rate of mortality for women aged 15-49 in Trondheim during the period 1830-1907, we must identify the maternal mortality. To do this we have to establish the number of maternal deaths that occurred during the same period. These numbers are listed in column 6 in Table 4. As with the total number of female deaths, the maternal deaths increase during the period in question.

Figure 8 presents the maternal mortality, which shows how the rate changes throughout the period of 1830-1907, in 5-year periods.

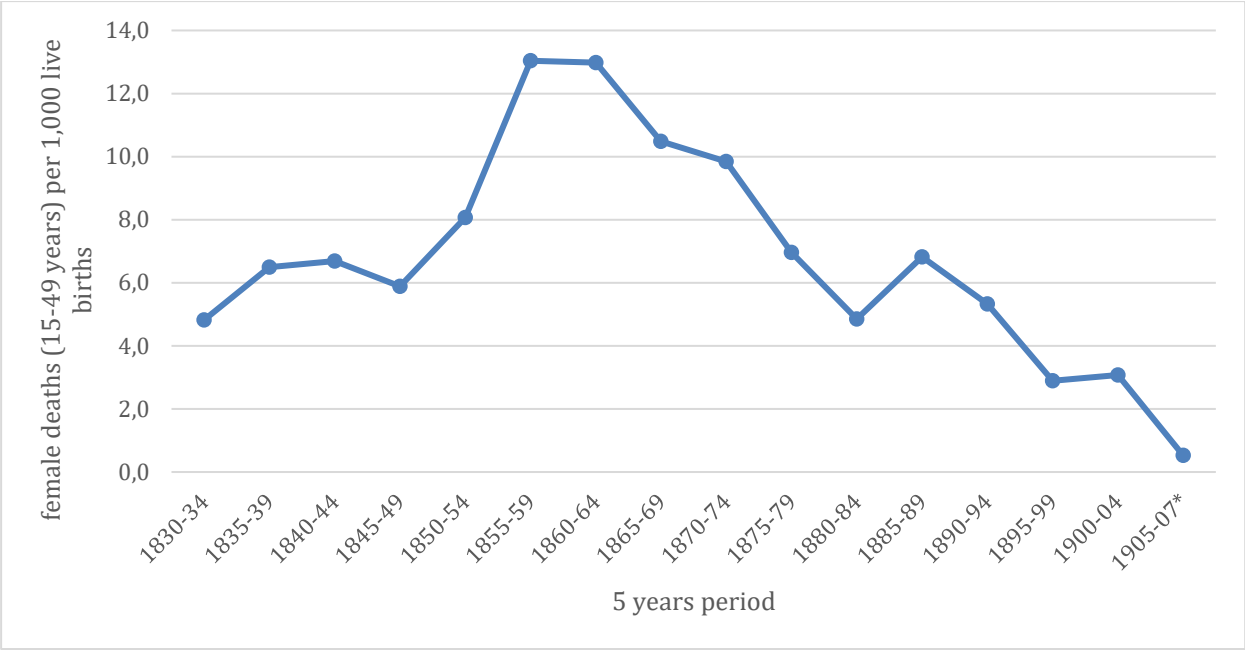

Figure 8 Maternal mortality per 1,000 live births, Trondheim 1830-1907

Source: The Norwegian Historical Data centre, UiT The Arctic University of Norway, Historical population register for Norway, [Funeral records, Bakkelandet parish, Domkirken parish, Ila parish and Vår Frue parish 1830-1907]. Original sources in Arkivverket

The graph illustrates the increases and decreases of the maternal mortality, exhibiting a somewhat parallel trajectory after 1890 as the graph presented in Figure 8. Notably, the interval 1850 and 1864 exhibits a substantial surge in mortality rates, followed by a gradual decline throughout the 19th century, except for a peak observed during 1885-1889. In the previous research section, reference was made to a graph found in Ida Blom's book, which portrays the decline in maternal deaths spanning from 1865 to 1980. Blom's graph comprises three distinct lines representing the decline in mortality rates for the entire nation, urban areas, and rural towns. It is worth noting that Blom's graph closely resembles the post-1865 trend in Figure 8, characterized by consistent declines in mortality over the given period. Nevertheless, Blom's graph does not exhibit the minor upsurge in deaths illustrated by Figure 8 during the period of 1884-1889. This similarity suggests that Trondheim, as concluded from the analysis of funeral records, followed a similar pattern to the rest of the country during the specified timeframe.

Irvine Loudon's' statistics for the maternal mortality in England and Wales between 1851-1860 show a rate of 47 deaths per 10,000 births. Loudon calculates his rate using deaths per 10,000 live births, while the calculation used for the deaths in Trondheim uses deaths per

1,000.[81] After converting the calculation in Trondheim, we find in a rate of 80.6 in the period 1850-54 and a rate of 130.4 in the period 1855-59. The mean rate between these two periods, a rate which more accurately represents the maternal mortality for the same period as Loudon's (1851-60), is 105.5. This stands as a huge contrast to Loudon's findings, indicating a much higher rate of maternal mortality in Trondheim alone than in England and Wales combined. In the previous comparison of Loudon and Högbergs findings, we saw that Loudon recorded a drop in maternal mortality from 47 to 5.6 per 10,000 births from 1851 to 1960, whereas Högberg identified a drop from 90 to 0.7 per 10,000 births from 1751 to 1980. In Trondheim we see that from 1855 to 1907 the rate dropped from 130 deaths per 10,000 births to 5. This tells us that Trondheim experienced a much higher rate of maternal mortality, and subsequently drop in said rate, than all of Sweden, and England and Wales combined, for a period 170 years shorter than in Sweden and a period 50 years shorter than in England and Wales. However, it is important to bear in mind that the smaller numbers in Trondheim are exposed to greater fluctuation than the more robust figures presented for Sweden and England/Wales. This means that a change in one death in Trondheim has a higher impact on the rate than a change in one death in Sweden. That said, the difference is very interesting and is worth further research in the future.

One way of examining the results of the maternal mortality further is to compare them to the level of total female mortality for same age groups. This comparison is provided in Figure 9.

[81] Loudon 1993:214

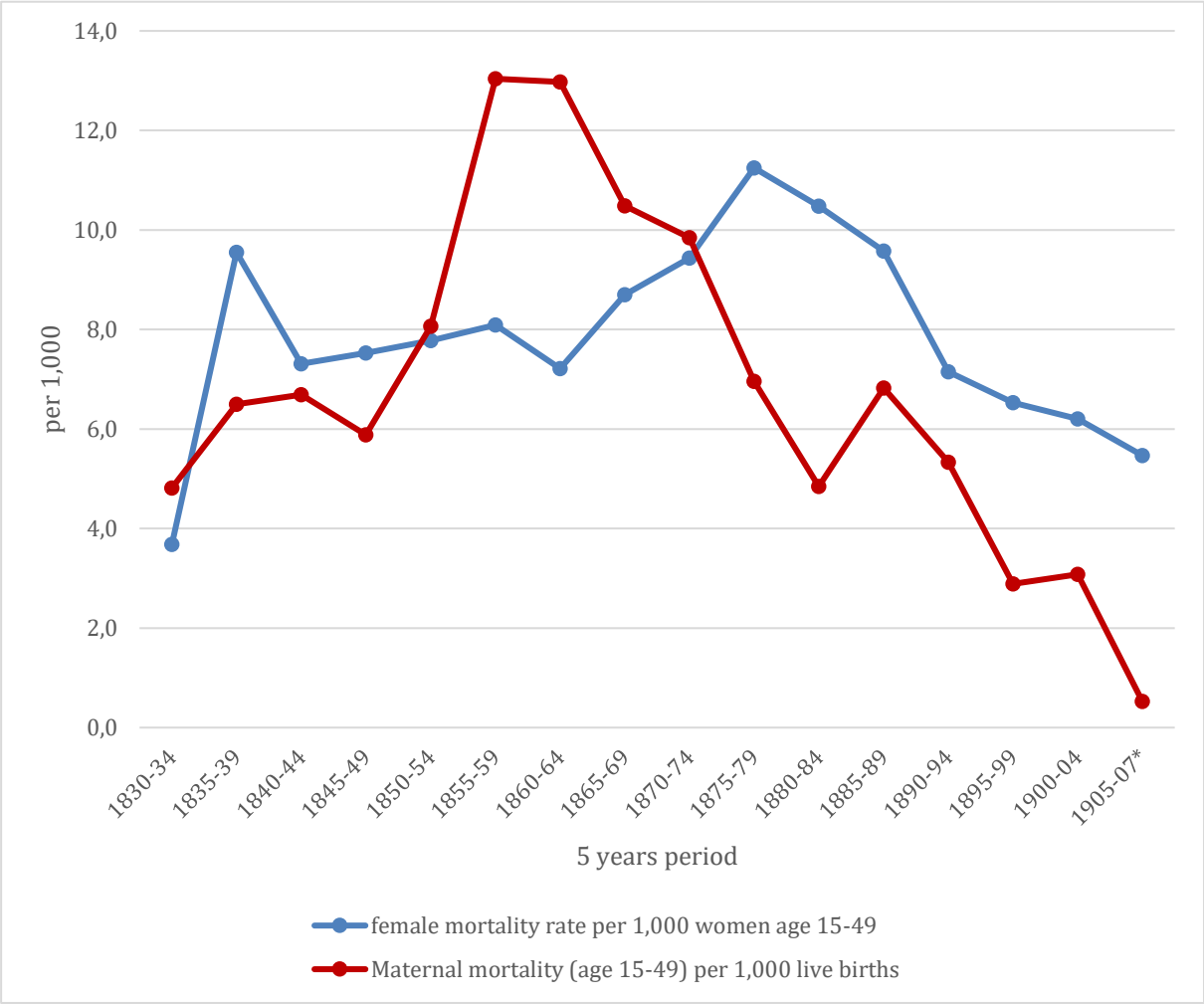

Figure 9. Female and maternal mortality per 1,000 women and 1,000 live births, Trondheim 1830-1907

Source: The Norwegian Historical Data centre, UiT The Arctic University of Norway, Historical population register for Norway, [Funeral records, Bakkelandet parish, Domkirken parish, Ila parish and Vår Frue parish 1830-1907]. Original sources in Arkivverket

The most obvious similarity is the decline in mortality after somewhere around 1890. Before we do any comparing it is important to remember that the rates are calculated using two different denominators, with female mortality using the censuses for women aged 15-49 and the maternal mortality using live births. This is important, as while female mortality is a measure of the total mortality for all women aged 15-49, the maternal mortality is restricted to maternal deaths measured by the number of live births. Perhaps the most interesting part of the comparison is the period between 1850 and 1874, where we see that the rate for the maternal mortality in Trondheim exceeds that of female mortality. This indicates that during this period in time women were more at risk of dying of a cause related to maternity than of any other cause. In addition to this, during their similar decline, the maternal mortality experienced a sudden surge between 1885 and 1889, whereas the female mortality continued

its decline. As previously explained, the decrease in mortality could be explained through the general increase in hygiene, medical advance and focus on bettering the public health. In addition to this, the discovery of the antiseptic method by Doctor Joseph Lister might also be an explanation to the decline, an explanation that we will go into more detail of later in the thesis.

Throughout most of the period, the rates of maternal death are lower than the rate of total female mortality. As well as this, the maternal mortality experienced a more fluctuating rate than the female mortality, which was somewhat steady overall in the period compared to the maternal mortality. The rates of maternal mortality are characterized by starting low from 1830 to 1849, with a sudden rise in 1850, reaching its peak in 1855-1864, before rapidly declining all the way through 1907 with the exception of the peak in 1885-89. During the period between 1830 and 1907, the lowest rate of female mortality was 3.7, and the lowest rate of maternal mortality was 0.5, neither of which ever reaching a rate of 0. The rate of female mortality reaching 0 would be curious, as this would indicate 0 female deaths, which would be almost unthinkable. However, the rate of maternal mortality reaching 0 could be more comprehensible, as developments in maternal healthcare was a fact throughout the 19th century. At its highest, the rate of female mortality was 11.2, meaning that for every 1,000 living women, 11.2 died. The rate of maternal mortality peaked at 13.0 between 1860 and 1864, meaning that for every 1,000 live births, 13 women died. These rates are not that far apart, which indicates that maternal mortality was a significant issue in 19th century Trondheim. This is also apparent in the 25-year period with a rate of maternal mortality higher than the female mortality.

One aspect that has not been discussed which is relevant to the decline in the maternal mortality rate, is the role of the midwives. Their significance must be emphasized and can be seen in the difference in mortality rates for Ignaz Semmelweis' two clinics in Vienna, with the clinic only staffed by midwives experiencing lower rates of maternal mortality. Sommerseth states in her article that:

> In Norwegian historiography, there is a broad agreement that 19th century public health measures such as vaccination programs, a focus on stillbirths, the introduction

> of education for midwives in 1810, and the establishment of health boards for each municipality, all contributed to the country's relatively low infant mortality levels.[82]

The focus on stillbirths and introduction of education for midwives most likely played a significant role in the decline of maternal mortality, as the education would have included medical training. When examining the development of the three birthing systems, we find characteristic changes from the beginning of the 19th century until the mid-20th century. Births have become safer for both mother and child, and they have shifted from home settings to institutions. At the same time, obstetrics has undergone a profound transformation, which tends to overshadow other explanations for the improved safety of childbirth.[83] Since the beginning of the 19th century, theoretical knowledge has gained more prestige than knowledge based on personal experiences. Traditional birth wives, who had developed their skills through attending home births and based their knowledge on their own experiences, were displaced by the midwives. Until the mid-1870s, most midwives were married and had given birth themselves. They, to some extent, preserved parts of the old knowledge system. However, gradually, unmarried women without personal experience took over the profession of midwifery, and the education provided in midwifery schools focused on schooling the midwives based on the physicians' knowledge.[84]

The rate of maternal mortality found in Trondheim during the period between 1830 and 1907 differ from the rates found by both Ulf Högberg in Sweden between 1791 and 1900, and by Julie Backer in Norway between 1856 and 1955. Högberg details a decline in maternal mortality from 90 to 0.6 per 10,000 live births over his 230-year period. In Trondheim, the highest rate of maternal mortality per 10,000 live births was 130 in 1855-59. As previously explained, the maternal mortality rate in Trondheim for women aged 15-49 saw a continuous decline, except for a sudden peak in 1885-89, with the rate dropping to 5 per 10,000 live births in 1905-07. The maternal mortality in Sweden declined by 89.3 over a 230-year period, resulting in a mean decline of 0.4 per year. In Trondheim, the rate declined by 125 over a 50-year period, resulting in a mean decline of 2.5 per year. This indicates that women aged 15-49 were more at risk of dying a maternal death far longer than women in Sweden, as well as

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[82] Sommerseth 2023:62

[83] Blom 1988:196

[84] Blom 1988:197

indicating that Trondheim city experienced a more rapid decline in the mortality. Julie Backers' report on mortality and its causes in Norway during 1856 and 1955 does not provide a specific number for the total amount of maternal deaths for the entire country. It does however show the rate of maternal mortality per 10,000 births for the years between 1900 and 1955, divided into the age groups 15-19, 20-29, and 30-39.[85] Here we see the highest rate of mortality being 54.9 per 10,000 live births in the age group 15-19 during the period between 1899 and 1902. This period differs from the ones used in this thesis, but the rate of maternal mortality in Trondheim during the same period would be approximately 3.0. This would be realistic, as Trondheim was expanding in both size and populace, and was on the way to become one of the bigger cities in Norway. Backer details how the rate of maternal mortality spreads out in her three defined age groups between the ages 15-39, but how does the maternal deaths in Trondheim vary across 5-year age groups?

4.3 Distribution of deaths by age groups

To start examining the distribution of deaths by age groups we must identify how the deaths vary through the parameter of women aged 15-49. When producing the statistics and examining the data, I found such low numbers in some of the ages that I have decided to make age groups defined by 5-year groups. This will make the statistics more relevant for the examination and analysis. The groups are also related to Ulf Högberg and Julie Backers' age groups, however only Backer details how the cases of maternal death vary across the groups, and as such only her research is relevant for comparison. The age groups and the distribution of maternal deaths within can be found in Figure 10.

[85] See table 1.

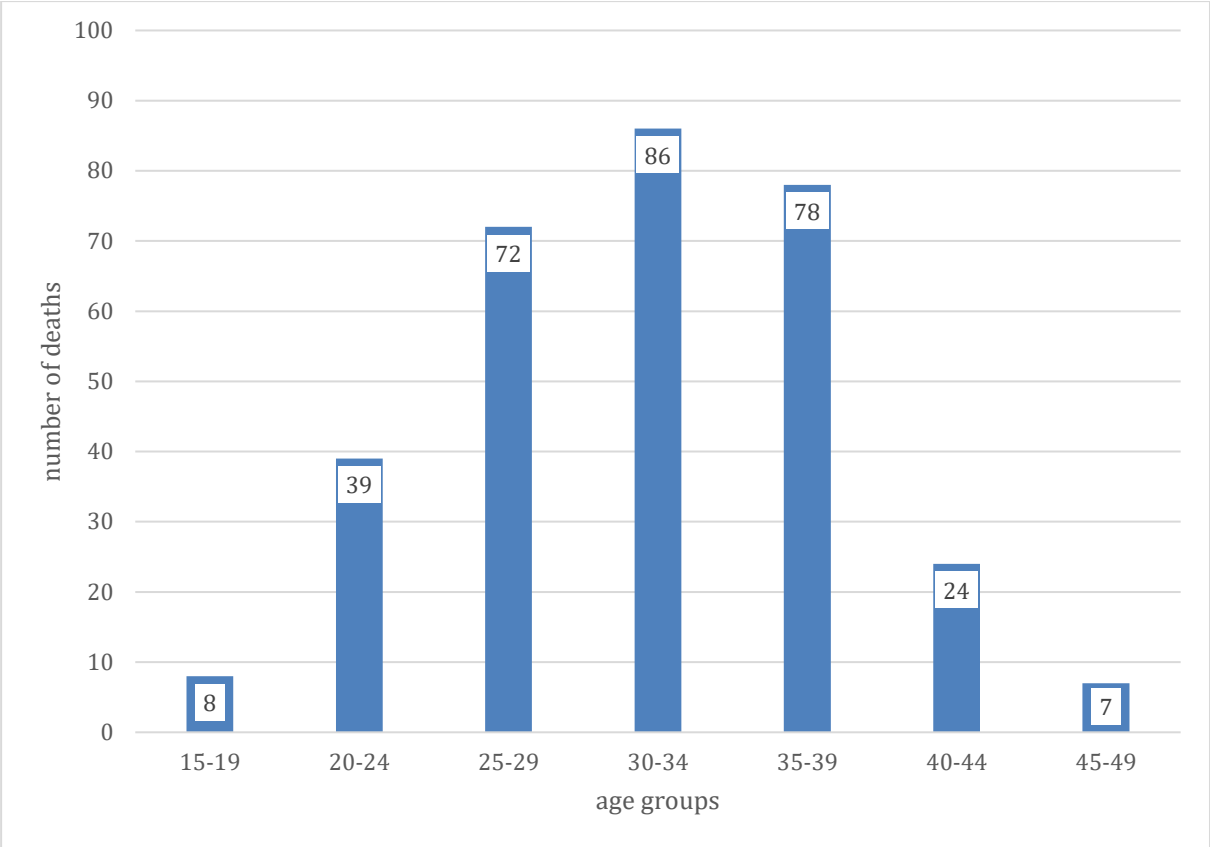

Figure 10 Maternal mortality for women aged 15-49, Trondheim 1830-1907

Source: The Norwegian Historical Data centre, UiT The Arctic University of Norway, Historical population register for Norway, [Funeral records, Bakkelandet parish, Domkirken parish, Ila parish and Vår Frue parish 1830-1907]. Original sources in Arkivverket

As we can see, the ages 25-29, 30-34 and 35-39 contain the highest numbers of maternal deaths. This could be explained through the previously explained risks of advanced maternal age, however we cannot verify this through the data at hand, as the rate of fertility follows the same trajectory as the bars in Figure 10. When considering the rate of fertility for women in Norway between 1846 and 1910, we see that Figure 10 correlates with the lines in Figure 11.

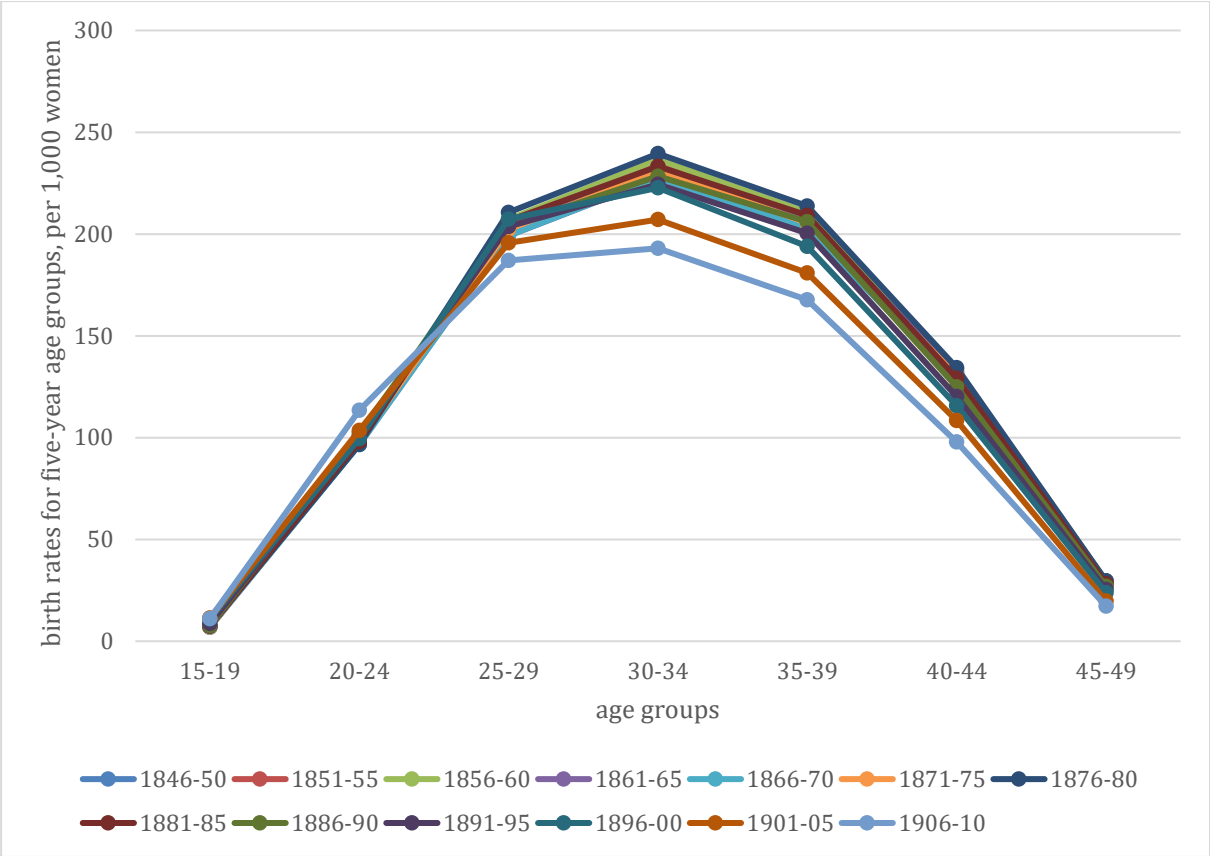

Figure 11 Rate of fertility for women aged 15-49 in Norway, 1846-1910

Source: Brunborg, H. (1988). Kohort- og Periodefruktbarhet i Norge 1845-1985. Statistisk sentralbyrå. https://www.ssb.no/a/histstat/rapp/rapp_198804.pdf p. 77

Figure 11 shows the birth rates for five-year age groups, per 1,000 women aged 15-49 in Norway between 1846-1910. The lines for each 5-year period follows the same trajectory as the graph in Figure 10. This shows that the explanation for the low rates of maternal mortality in the age groups "15-19" and "45-49" is due to the low number of births for those groups. The low rates of maternal mortality in these groups only tells us that fewer women in these ages gave birth, which also means that there are fewer deaths among women in these age groups. The high rates of maternal deaths in the age groups "30-34", "35-39", and "40-44" could be explained through the previously advanced maternal. The term is used to describe women aged ≥35 years and is used as a category for high-risk pregnancies. In other words, this category of women is at a higher risk of complications during pregnancy or birth, or in the postpartum period. In an article in the Journal of Women's Health, authors Rosaly Correa-de-Araujo and Sung Sug Yoon research the clinical outcomes in high-risk pregnancies due to advanced maternal age. In the article they mention how: "Large studies worldwide

consistently report a significant increased risk for stillbirth in women age ≥35 years."[86] The authors also describe how through an analysis of 37 million deliveries it has been found that women aged 45-54 years has a 3.5 times higher risk of severe maternal morbidity. In a different study of near 65,000 pregnant women, it was found that women age ≥35 years had "increased frequency for antepartum hemorrhage, placenta previa, hypertension, gestational diabetes, and overweight or obesity."[87] This tells us that women of advanced maternal age are more likely to develop maternal morbidities, morbidities that in a period with less advanced medicine, i.e., the 19th century, would make the woman at high risk of maternal death. However, when analysing and comparing figures 10 and 11, advanced maternal age as an explanation to the higher amounts of maternal deaths in the groups containing women aged >29 is to some degree disproven. As previously explained, the higher numbers correlate with there being a higher number of births within the same age-groups. This can be explained through the obvious increase of risk of death parallel with the increase in births. Figure 11 depicts the rate of fertility for the entire country, not specifically Trondheim, but it may play a part in explaining the distribution of maternal deaths shown in Figure 10.

This brings us to our next point of analysis on the maternal mortality: causes of death. We must identify the causes of maternal death in the period between 1830 and 1907, which can be found in Table 5. The table identifies each cause of maternal death through the ICD-10h classification system, with corresponding labels. The amounts are also represented through which percentage the cause of death take up of the total number of deaths. As one can see from Table 5, O75.900, O85.001 and O95.000 take up the largest percentages of the total number of deaths. Since the remaining causes have so few cases, I have decided to focus on these three when looking at the cause specific mortality for the age-groups defined in the thesis. In Chapter 3.4.3, I refer to an article that provides detailed information on mortality rates among women of fertile age during the period spanning from 1866 to 1900 in Norway. The article reveals that 9% of deaths in this population were attributed to childbirth-related complications. Comparatively, in Trondheim during the same period, maternal deaths accounted for 6.8% of all deaths among women aged 15-49. Furthermore, the article

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[86] Correa-de-Araujo, R. & Yoon, S.S. (2021). Clinical Outcomes in High-Risk Pregnancies Due to Advanced Maternal Age. *Journal of Women's Health (2002), 30*(2), 160-167. https://doi.org/10.1089/jwh.2020.8860. p.163

[87] Correa-de-Araujo & Yoon 2021:164

highlights the high risk associated with childbirth-related hospital stays ("barselseng"), as evidenced by the examination of cases coded as O75.900 in the ICD-10 classification system. Remarkably, this particular code represents 31.25% of all recorded cases of maternal death within the given timeframe in Trondheim.

ICD10h	Classification term, English	Original term (standardised)	Count	Percentage
O06.000	Unspecified abortion	Abort	2	0.6
O08.200	Embolism following abortion and ectopic and molar pregnancy	Pyæmi (Abortus)	1	0.3
O15.000	Eclampsia	Eclampsia purpuralis	12	3.8
O15.900	Eclampsia, unspecified as to time period	Barselkrampe	6	1.9
O60.100	Premature labour and delivery, mother	Fortidlig nedkomst	4	1.3
O67.900	Intrapartum haemorrhage, unspecified	Forblødning under fødsel	2	0.6
O71.100	Rupture of uterus during labour	Ruptura uteri partus	1	0.3
O72.000	Postpartum haemorrhage	Hæmorrhagia ante partum et im partus	1	0.3
O75.900	Complication of labour and delivery, unspecified	Barselseng	103	32.8
O85.001	Puerperal fever	Barselfeber	131	41.7
O95.000	Obstetric death of unspecified cause	Barselfærd	47	15.0
O99.000	Anaemia complicating pregnancy, childbirth and the puerperium	Anæmi, 8 dage efter forløsning	1	0.3
O99.300	Mental disorders and diseases of the nervous system complicating pregnancy, childbirth and the puerperium	Mania puerperalis	2	0.6
O99.500	Diseases of the respiratory system complicating pregnancy, childbirth and the puerperium	Brystsyge - nylig havt barsel	1	0.3
Total			314	100

Table 5 Causes of maternal death for women aged 15-49, Trondheim 1830-1907

Source: The Norwegian Historical Data centre, UiT The Arctic University of Norway, Historical population register for Norway, [Funeral records, Bakkelandet parish, Domkirken parish, Ila parish and Vår Frue parish 1830-1907]. Original sources in Arkivverket

The number of deaths per age group for the three causes of deaths with the highest mortality can be found in Figure 12. The table consists of the age groups in 5-year ranges, followed by the cause of death identified by the respective code in ICD-10h. As we can see, there are fewest deaths in the age group 15-19, and most in the age group 30-34. In continuation of the analysis on the spread of maternal death in the age groups from Figure 10, we can see that puerperal fever/sepsis is the cause of death most women aged ≥34 die of.

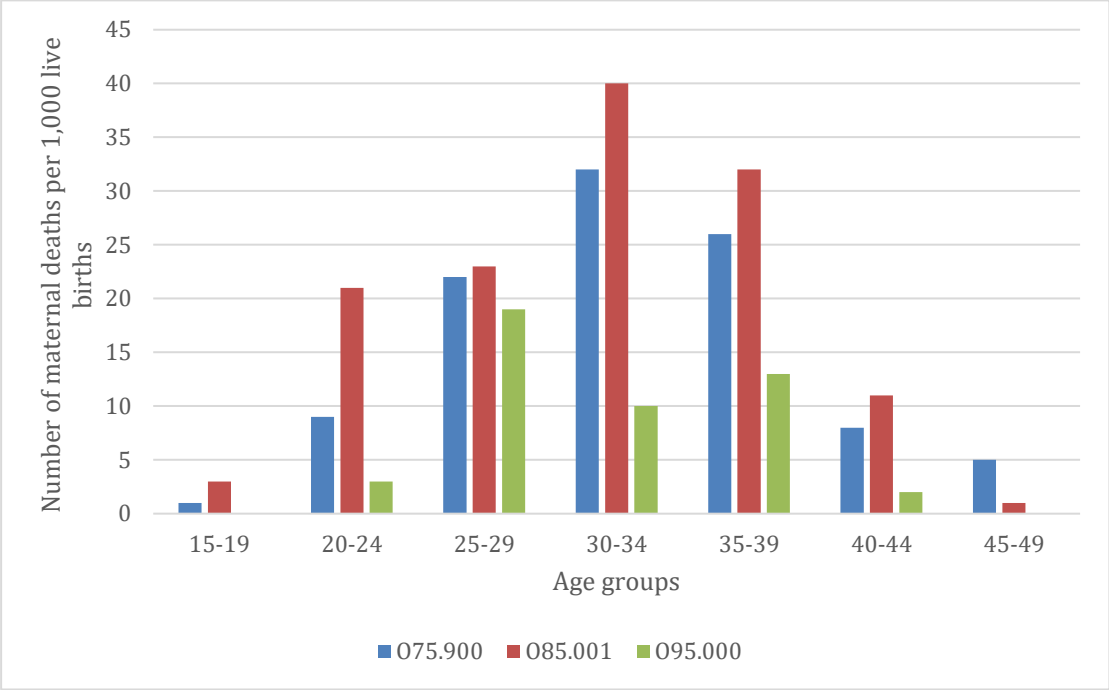

Figure 12 Cause specific maternal death per 1,000 live births for women aged 15-49, Trondheim 1830-1907

Source: The Norwegian Historical Data centre, UiT The Arctic University of Norway, Historical population register for Norway, [Funeral records, Bakkelandet parish, Domkirken parish, Ila parish and Vår Frue parish 1830-1907]. Original sources in Arkivverket

In continuation of the previous research done by Doctor Pooja Sharma, who identified eclampsia and haemorrhaging as the leading causes of maternal death today, we can see that these causes make up only a small portion of the deaths in Trondheim between 1830-1907, and we can even see that haemorrhaging is not explicitly listed as cause in any of the cases. I say explicitly because there is a case with "anaemia" as the registered cause of death. Anaemia affects nearly 40% pregnant women worldwide and has been associated with higher

rates of maternal death.[88] The original description of the cause of death translates to "Anaemia, eight days after birth", which could indicate that the mother died from loss of blood, which could have been caused by haemorrhaging. As to eclampsia, 18 maternal deaths in Trondheim were related to this cause, which makes up 5.7% of the total number of maternal deaths. This differs from Sharma's findings. If we were to use Sharma's findings as a basis, a possible explanation to the low numbers of cases in Trondheim could be the under-registration of maternal deaths by doctors who feared damage to their reputation. A doctor who couldn't save a woman from bleeding out might have been afraid of his reputation being spoiled. Another explanation could be the possibility of cases of haemorrhaging being placed in the category of "barselseng".

In an article researching pregnancy-associated severe sepsis, or PASS, Lavi Oud lists risk factors for development of the disease, one of which being advanced maternal age.[89] He also explains how: "Severe sepsis in the obstetric population can become rapidly fatal."[90] Oud elaborates by explaining how an article on maternal mortality and severe morbidity from sepsis in the Netherlands, written by Kramer, et al., found that in eight of the cases the women developed sepsis within 24 hours, and of those eight, six died within 24 hours and two within 48. These women were aged between 21-35 years.[91] In Table 5 we can clearly see that puerperal sepsis is the leading cause of maternal death in the period between 1830 and 1907. This data, and the articles researching the maternal mortality in both the past and present, tell us that puerperal sepsis was and still is a leading cause in maternal deaths. However, the registering of sepsis as a cause of maternal death increased only after the discovery of the anti-septic method. Any cases of puerperal sepsis beforehand could indicate that the priests/doctors assumed sepsis due to the women having a fever, and associated the fever with pregnancy, resulting in "Puerperal fever/sepsis" being listed as the cause of death. This aspect

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[88] Smith, C., Teng, F., Branch, E., Chu, S., & Joseph, K. S. (2019). Maternal and Perinatal Morbidity and Mortality Associated With Anemia in Pregnancy. *Obstetrics and gynecology*, 134(6), 1234–1244. https://doi.org/10.1097/AOG.0000000000003557. p.1234

[89] Oud L. (2014). Pregnancy-Associated Severe Sepsis: Contemporary State and Future Challenges. Infectious diseases and therapy, 3(2), 175–189. https://doi.org/10.1007/s40121-014-0037-7. p.181.

[90] Oud 2014:182

[91] Kramer, H. M., Schutte, J. M., Zwart, J. J., Schuitemaker, N. W., Steegers, E. A., & van Roosmalen, J. (2009). Maternal mortality and severe morbidity from sepsis in the Netherlands. *Acta obstetricia et gynecologica Scandinavica*, 88(6), 647–653. https://doi.org/10.1080/00016340902926734. p. 649-650.

of the registration of causes of death will be further discussed in chapter 4.4. It will therefore be interesting to see if sepsis still occurs as the leading cause of maternal death when looking at the distribution of maternal deaths by cause of death and periods.

4.4 Causes of death

As previously shown in Table 4, the highest number of maternal deaths occurred during the period of 1855-1879. This is also represented in the higher rates of mortality, as the number of births does not increase in parallel with the number of maternal deaths. When analysing the statistics, it is of interest to know which causes of death are present in these periods, and if this can explain the sudden rise in deaths. It is also of interest to examine if there is any proof of the change in registration practice. These are represented in Table 6.

English description of ICD10h	ICD10h	1855-1859	1860-1864	1865-1869	1870-1874	1875-1879
Eclampsia	O15.000	0	1	1	2	1
Eclampsia, unspecified as to time period	O15.900	0	0	1	1	0
Premature labour and delivery, mother	O60.100	0	0	0	0	1
Intrapartum haemorrhage, unspecified	O67.900	0	0	1	0	0
Complication of labour and delivery, unspecified	O75.900	11	11	6	12	6
Puerperal fever	O85.001	7	16	24	14	18
Obstetric death of unspecified cause	O95.000	15	7	0	0	0
Anaemia complicating pregnancy, childbirth, and the puerperium	O99.000	0	0	0	1	0
Mental disorders and diseases of the nervous system complicating pregnancy, childbirth, and the puerperium	O99.300	0	0	0	2	0
	Total deaths	33	35	33	32	26

Table 6 Description of cause specific maternal deaths, Trondheim 1855-1879

Source: The Norwegian Historical Data centre, UiT The Arctic University of Norway, Historical population register for Norway, [Funeral records, Bakkelandet parish, Domkirken parish, Ila parish and Vår Frue parish 1830-1907]. Original sources in Arkivverket

In the period of 1855-1859 we can see that nearly 50% of maternal deaths are classified as O95.000, “Obstetric death of unspecified cause”. In the remaining periods we see that most deaths are classified as O85.001, “Puerperal fever”, sometimes also referred to as “Puerperal sepsis”. This variation in registration of O85.001 in the church books could indicate a change in understanding of the cause of death. In the period 1860-1879 there were a total of 72 deaths caused by puerperal fever. What could have caused this sudden increase in cases of O85.001 and decrease in cases of O95.000? And is there a correlation between the rise in cases of puerperal fever and decline in cases of unidentified and unspecified causes of death? One can also ask why the period of 1855-1859 had so many cases coded as O95.000 (Obstetric death of unspecified cause), until after 1864 when these causes are no longer listed? In combination with this we can also see a slight decrease in cases of unspecified complications of labour and delivery (O75.900). Does this change in cause of maternal death have more to do with the specification of cause of death than with a particular increase in deaths from puerperal fever? To address this, we need to consider both the previously detailed discovery made by Ignaz Semmelweis and any other potential findings regarding the registration of causes of death.

When researching changes in the view of medicinal approaches, Joseph Lister is mentioned. Doctor Joseph Lister (1827-1912) was a British surgeon and scientist who pioneered the study of antisepsis.[92] During the time Lister practiced medicine, surgical knowledge was limited. Even though microorganisms were known to be associated with diseases since the 16th century, a correlation between germs and infections in wounds had not yet been found. Bed covers, surgeon’s coats and surgical tools were as a result rarely cleaned, and pus formation was considered part of the natural wound-healing process. Lister made a remarkable observation that infections in wounds was associated with exposure to air and began successfully applying an antiseptic approach to surgery. He based this on an understanding of if no germs were present there would be no infection, which would result in no disease.[93]

> Joseph Lister helped introduce germ theory and laid the foundation for the use of antiseptics in the practice of medicine and surgery. Today, asepsis and sterile

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[92] Michaleas S N, Laios K, Charalabopoulos A, et al. (December 21, 2022) Joseph Lister (1827-1912): A Pioneer of Antiseptic Surgery. Cureus
14(12): e32777. DOI 10.7759/cureus.32777. Abstract.

[93] Michaleas, Charalabopoulos, et al., 2022, p.2

> techniques have replaced antisepsis as the principal method in combatting wound infection. Lister's observations and recommendations helped revolutionize surgical practice, making surgery and wound healing safer for patients.[94]

This increased understanding of the spread of germs might have influenced the understanding of all deaths caused by sepsis, including puerperal sepsis/fever. Lister introduced his antiseptic method and spray apparatus in 1865, when experimenting with carbolic acid on an 11-year-old boy. Said boy had a bone fracture, on which Lister applied carbolic acid solution on a pad and placed on the wound. After 4 days Lister removed the pad and found no sign of infection, and that the fracture had started to heal.[95] Listers work on antiseptic understanding might have influenced the knowledge of sepsis and seeing as his discovery of the effect of his method occurred in the same period as the increase in puerperal fever as a cause of maternal death in Trondheim, such a conclusion is possible to make. When Lister introduced a way to fight infections in wounds, there is an argument to make that this made more doctors aware of potential symptoms of sepsis, leading to an increase in "puerperal sepsis" being named as the cause of death. This means that there was not necessarily an increase in cases of puerperal fever/sepsis, but rather an increase in knowledge of identifying symptoms of sepsis, and then classifying the deaths thereafter. This could explain the rise cases of O85.001 and decline in cases of O75.900 and O95.000. Listers discovery does however not correspond with the rise in cases prior to 1865. It is intriguing to note the occurrence of an increase in the number of cases, particularly when considering the seminal findings of Ignaz Semmelweis regarding the transmission of puerperal fever. Despite the logical expectation that the two aforementioned discoveries would yield a decrease in cases of puerperal sepsis, the results from the church books in Trondheim argues with this hypothesis.

When searching for any indication of this in the reports on the state of health of the population, the first time anything related to sepsis shows up is in the report from 1868. When detailing cases of nerve fever, the report describes symptoms and uses the word "septisk".[96]

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[94] Michaleas, Charalabopoulos, et al., 2022, p.6

[95] Michaleas, Charalabopoulos, et al., 2022, p.4

[96] Norges officielle statistic (NOS). (1871). Beretning om Sunhedstilstanden og Medicinalforholdene I Norge I Aaret 1868. [Report on health and medical situation in Norway 1868]. Departement for det indre. https://www.ssb.no/a/histstat/div/is/is_93.pdf. p. 19

This is also found in the report from 1890, and again the mentioning is not related to maternal death. The report has included "Septichæmi og Pyæmi" in its list of causes of death.[97] The second time sepsis is mentioned is in the report from 1900. Three times in this report is the knowledge of sepsis mentioned. The first time is in the chapter detailing the health reports in Akershus County, when talking about "barselfeber", which as we know is a term for puerperal sepsis, and how the midwives have become very skilled when it comes to antiseptic measures.

> Af Barselfeber er ialt anmeldt 15 Tilfælde, hvoraf 6 dødelige. Der forekom dette Aar mod Sædvane intet Tilfælde i Sørum, Gjerdrum eller nedre Del af Ullensaker; Jordmødrene er nu meget dygtige og renlige i sin Gjerning, og overholder strengt Aseptikens Love baade med Hensyn til de Fødende og sig selv[98]

The second time sepsis is mentioned is when discussing meetings and courses done in Stavanger County, where the hospital had arranged a course in antiseptic method, on which all the midwives had attended. "Ved Sygehuset afholdtes et Kursus i Antiseptik for Jordmødrene, der næsten samtlige mødte frem",[99] The last mention of sepsis is when discussing "barselfeber" in Romsdal County, where two of the cases of maternal deaths with puerperal sepsis as the cause happened at the practice of the same midwife, whom had been trained at the "old" school and had not much experience with the antiseptic method. "Blandt Tilfældene i Ytr e Romsda l tilhørte 2 samme Jordmoders Praxis; hun er af den gamle Skole og har vanskelig for at følge med, hvad Antiseptik ang-aar".[100] These reports indicate an increase in the knowledge of sepsis, and to a degree confirm my speculation on the cause of the increase in cases of puerperal sepsis after 1864. The discoveries attributed to Joseph Lister and Ignaz Semmelweis are likely to have contributed to the reduction in puerperal fever cases

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[97] Norges officielle statistic (NOS). (1892). Beretning om Sunhedstilstanden og Medicinalforholdene I Norge I Aaret 1890. [Report on health and medical situation in Norway 1890]. Direktøren for det civile Medicinalvæsen. https://www.ssb.no/a/histstat/nos/nos_iii_162.pdf. p. 20

[98] Norges officielle statistic (NOS). (1902). Beretning om Sunhedstilstanden og Medicinalforholdene I Norge I Aaret 1900. [Report on health and medical situation in Norway 1900]. Direktøren for det civile Medicinalvæsen. https://www.ssb.no/a/histstat/nos/nos_iv_055.pdf. p.26

[99] NOS 1902:141

[100] NOS 1902:195

and, consequently, the decline in maternal mortality. However, this is by Irvine Loudon in his research paper discussing historical maternal mortality.

> Contrary to perceived wisdom, Semmelweis's work between 1847 and 1860 on the use of antisepsis to prevent puerperal fever had virtually no effect on deaths from puerperal fever in any country. Around 1880, Listerian antisepsis was gradually introduced into obstetrics, which greatly reduced the maternal mortality rate in maternity hospitals[101]

Loudon continues by detailing the decline in maternal mortality rates in the north-western parts of Europe, proving to some degree that the gradual decline observed could potentially be attributed to the incremental spread and acceptance of the methodologies advocated by Lister and Semmelweis.[102]

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[101] Loudon, I. (2000). Maternal Mortality in the past and its relevance to developing countries today. *The American Journal of Clinical Nutrition, 82*(1). 241S-246S. https://doi.org/10.1093/ajcn/72.1.241S p. 242S

[102] Loudon 2000:242S

5 Conclusions

The study of maternal mortality and its causes in a defined period in a specified geographical area can give insight into what characterized maternal healthcare during that time. This study could also help us understand how we understood contagion and practiced preventative care, and for a period containing advancements in both, the 19th century is a very good place to start. The century can be characterized by its large societal changes, pertaining both to the growing populace and culture and a focus on improvements to the public healthcare services, to name a few, as well as changes in medical practice. One example of this is the discovery of the antiseptic method by Doctor Joseph Lister, which, by analysing the results in this thesis' search for causes of maternal death, seems to have made an impact in the Norwegian doctors' understanding of puerperal sepsis.

This thesis has explored how the rate of both female and maternal mortality was characterized in Trondheim during the period between 1830 and 1907. The choice of Trondheim as a focus area and the period between 1830 and 1907 is based on the availability of the data needed for this research, and the societal changes and developments in healthcare Trondheim experienced during the 19th century. The rates of female and maternal mortality have been compared to understand the severity of maternal mortality. In addition to this, the causes of maternal death have also been researched, for the very same reason. The thesis was looking for an answer to the thesis question: **What characterizes the level and trends of maternal mortality during the 80 years prior to the opening of the maternity hospital?** The thesis also aimed to answer the following subtopics:

1. How does the maternal mortality compare to the rate of total female mortality for women aged 15-49?
2. What characterizes the maternal causes of death registration in Trondheim during the period 1830-1907?

The maternal mortality was already at a decline, but E.C. Dahls foundation undoubtedly helped these number decrease even more. This, combined with the change in position on theory of infection would result in a significant drop in maternal death in Trondheim, in accordance with the total mortality in the city. In addition to this, the maternal mortality experienced a decline most likely due to the establishment of E.C. Dahl's foundation. In the

years after the period researched in this thesis, the rate of maternal mortality continued its decline, with the foundation undoubtedly playing a significant role.

The thesis question and corresponding subtopics have been answered through both the periodization of the female and maternal mortality in the period and the study of cause specific maternal mortality in Trondheim. Through this research I have found that the maternal mortality in Trondheim can be characterized as fluctuating but declining. The rate of mortality reached a peak in the period between 1855-1864, before experiencing a somewhat steady decline. The surge in cases of puerperal sepsis/fever, which can be attributed to the improved recognition and understanding of its symptoms, provides a plausible explanation for the peak observed. The decline was explained through the general enhancements in healthcare and the developments made in medical practices. In addition to this, the comparison of the total female mortality and the maternal mortality provided interesting results. For a period of 25 years, women were at more risk of dying a maternal death than anything else, and during the rates' declines we saw a sudden surge in the rate of maternal death. This indicates that women were at a high risk of dying during or shortly after childbirth, with the rate reaching its lowest point of 0.5 at the end of the period researched.

As a way of validating my findings I have discussed the previous research done related to this thesis' focus on maternal mortality. Through this I have discovered how the decline in the rate of maternal mortality was not confined to Trondheim, but was something experienced in the entire country, as well as in Sweden, England, and Wales. The comparison of the findings in Trondheim and the previously mentioned countries resulted in the discovery of a higher rate of maternal death in Trondheim. This is rather interesting, as this indicates that women in Trondheim were more at risk of dying a maternal death than in the corresponding countries. However, this does not mean that more women died in Trondheim, only that the rate of women dying compared to live births was higher. It indicates a higher risk of death, not a higher number of women dying. In both the chapter describing previous research and the chapter pertaining the analysis of the results, I discussed the term "advanced maternal age". The term is used to characterize women aged $\geq$35, which have been found to have an increased risk of complications during pregnancy and childbirth. This was however somewhat disproven, as the results in this study found that the increased amounts of maternal deaths for the ages $\geq$35 correlated with the increased fertility rates of the same ages.

The subtopic pertaining to what causes of maternal death were prevalent in Trondheim was answered through Table 5. The table shows us that puerperal sepsis/fever makes up almost 42% of all cases of maternal death with 131 deaths. This cause of death, combined with the cause "Complication of labour and delivery, unspecified" which contained 103 cases of maternal death, make up nearly ¾ (74.5%) of all maternal deaths in Trondheim during the period between 1830 and 1907. As we saw in Table 6, puerperal sepsis/fever rose as a cause of death after 1855. Unspecified complications of labour and delivery remained as a high cause of death during the entire period. This could have been because of the cases where there was no doctor present to classify what caused the death of the mother, and the standardized version "barselseng" strengthens this explanation, as this directly translates to "maternity bed". This description of a cause of death is as unspecified as they come. The rise in cases of puerperal sepsis could indicate a change in the registration of causes of death, with cases prior to 1855 likely being registered as puerperal sepsis as a result of women dying of a fever. These cases could have been identified as such by the doctor/priest only seeing these two factors: pregnancy and fever. In addition to this, many of the cases' original listing varies between puerperal sepsis and puerperal fever, with 86 of the 131 cases using "puerperal fever".

5.1 Further study

Social aspects have undoubtedly played a part in the results analysed in this study, however researching this would have been too much for this thesis. It would be interesting to research what role the marital status of the women could have played in the rates of maternal mortality. This could give an indication as to the quality of healthcare provided to wed and unwed mothers and could comment on the role of a women in a marriage. As well as this it would be interesting to research the change in language used to describe the cause of death in the funeral records. A study dedicated to the changes in Norwegian written language could uncover any geographical differences within the country and could also indicate whether doctors and priests were conservative when it came to the choice of written language used. Lastly, as this study focused on the harbour town Trondheim, a comparison to a different harbour town in Norway would be interesting. This would yield the chance to compare demographic changes and if these changes could have played part in the rate of maternal mortality. It would also be interesting to examine the age specific mortality through data from the Norwegian Historical Population Register. This could be done by gathering information on the mothers age when giving birth, and then analysing the spread of maternal deaths

compared to live births. In addition to this, analysing any possible wrongful registration of cause of death would also be of interest, by searching the NHPR for cases of women dying during or shortly after childbirth, but being listed as having died of a cause not related to maternity.

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