

Does Intelligence Predict Childlessness in Men?

*An Analysis of the Direct and Indirect
Associations Between Intelligence and
Childlessness in Men.*

Audun Hustad Torgersen



Innlevert som hovedoppgave ved Psykologisk institutt

UNIVERSITETET I OSLO

15.10.2019

© Audun Hustad Torgersen

2019

Does intelligence predict childlessness?

Audun Hustad Torgersen

<http://www.duo.uio.no/>

Trykk: Reprosentralen, Universitetet i Oslo

Abstract

Author: Audun Hustad Torgersen

Title: Does Intelligence Predict Childlessness in Men?

Supervisor: Tilmann von Soest

Background: In many European countries, the rate of childlessness has increased and this increase is disproportionately large among men. It is thus important to study the antecedents of childlessness. Intelligence as a predictor of childlessness has received some attention, although the findings are conflicted. Men with less education, lower wages and no partner seem to be overrepresented among the childless. These factors are known to be associated with intelligence. However, little is known about how these factors may mediate the association between intelligence and childlessness.

Method: The present study analyzed data from the Young in Norway survey, which had been linked to the Historical Event Database (FD-Trygd) of Statistics Norway, in addition to intelligence scores from the evaluation for mandatory military service for all men in Norway. Intelligence scores were used as predictors of childlessness. Information on education, income and relationship history was retrieved from both the Young in Norway survey and the FD-trygd register. Mediation analyses with logistic regression analysis were performed in order to examine the direct and indirect effect of intelligence on childlessness.

Results: No linear association between intelligence and childlessness was found. However, follow-up analyses showed that higher risk of childlessness was associated with the highest stanine intelligence score (two standard deviations above the normed average), and that this effect was mediated by whether participants had ever been in a relationship by their late twenties. No significant direct effect of the highest stanine intelligence score was found when the question of whether participants had ever been in a relationship by their late twenties was included.

Conclusion: The present study revealed a complex association between intelligence and childlessness. The mediated association between the highest stanine intelligence score and childlessness was interpreted as an expression of delayed family formation. It is still unclear whether this delay in family formation will “catch up” if childlessness is measured at an older age, which raises the need for additional studies on the subject.

Preface

The present study was based on data from the Young in Norway longitudinal project. I would like to thank my supervisor Tilmann von Soest for allowing me to write my thesis on this fascinating data set, and for providing excellent supervision along the way. He has guided my efforts with a gentle hand, while at the same time allowing me to explore the fascinating world of psychological research on my own. His excellent knowledge of both psychological theory and method has proved invaluable along the way.

I also need to thank my wonderful wife Karethe Hustad Torgersen for proofreading, and for the support and patience she has given me throughout this project. I could not have done it without her. In addition, I would like to thank my parents for supporting me through the writing of this task, and for letting me bounce ideas of them throughout the writing process.

Finally, I need to thank my friends for cheering me along all the way to the finish line, and for providing both distraction and support in turn, always exactly when I needed it the most.

Oslo, October 2019

Audun Hustad Torgersen

Table of contents

1	Introduction	1
1.1	Childlessness	2
1.2	Intelligence	4
1.3	The link between intelligence and childlessness.	5
1.3.1	Direct effects	6
1.3.2	Indirect effects.....	7
1.4	Intelligence as a predictor of childlessness.....	7
1.5	Direct and indirect associations between intelligence and childlessness	11
1.5.1	Partnership history.....	13
1.5.2	Socioeconomic factors	15
1.6	Summary.....	19
1.7	Research questions and hypotheses:.....	20
2	Method	22
2.1	Procedure and participants.....	22
2.2	Measures	23
2.3	Ethical considerations.....	25
2.4	Statistical analyses	25
3	Results	28
3.1	Descriptive statistics	28
3.2	Preliminary analyses.....	30
3.3	Direct and indirect associations between intelligence and childlessness	34
4	Discussion	43
4.1	The total association between intelligence and childlessness	43
4.2	The indirect effects of intelligence on childlessness.	46
4.2.1	Partnership history.....	46
4.2.2	Socioeconomic factors	48
4.3	The direct effect of intelligence on childlessness.....	50
4.4	Strengths and limitations	51
4.5	Conclusion.....	54
	References	56

Figure 1: Distribution of intelligence scores in the sample.....	28
Table 1: Descriptive statistics for all study variables (N = 1.118).....	29
Table 2: Descriptive statistics of the population of childless men vs those who have had at least one child.....	31
Table 3: Correlation table.....	32
Figure 2: Distribution of childlessness by intelligence score.....	35
Table 4: Logistic regression analysis with intelligence treated as a categorical variable and childlessness as the outcome variable	36
Table 5: Logistic regression analysis of each study variable individually with childlessness as the outcome variable controlling for age.....	38
Table 6: Logistic regression analysis with intelligence as the predictor variable and ever having been in a relationship in 2005 as the outcome variable. Age was controlled for.	39
Table 7: Logistic regression analysis of intelligence and potential mediating variables with childlessness as the outcome variable.	40

1 Introduction

Childlessness is becoming an increasingly common phenomenon across developed countries the world over. One out of five remain childless throughout their lives in several European countries (Miettinen, Rotkirch, Szalma, Donno, & Tanturri, 2015). In addition, the increase in childlessness rates have been claimed to be partly responsible for the declining average fertility rates across Europe (Miettinen et al., 2015). In her New Year's address the Norwegian prime minister warned that the welfare state could not be supported by the current birth rates, and encouraged the Norwegian population to have more children (NRK, 2019).

Men are overrepresented in the childlessness statistic for almost every single European country, and most of these are involuntarily childless (Miettinen et al., 2015). One in four (25.6%) of all Norwegian men born in 1960 remained childless in 2004, compared to one in six (16.7%) of Norwegian women (Skrede, 2004). While childlessness rates are increasing for both genders, this increase is faster for men than women (Jensen & Østby, 2014).

This is not only a societal problem. Childlessness has adverse consequences for those affected on an individual level, and this effect seems to be larger for men than for women. Childless men having been found to have increased mortality rates (Fieder & Huber, 2007; Weitoft, Burström, & Rosén, 2004), in addition to lower levels of income and less engagement in their community (Keizer, Dykstra, & Poortman, 2009).

Despite these facts, fertility research has historically been focused on women, with interest in men appearing only in recent years. Considering the present trends in childlessness, more research is needed on childlessness in men. Knowledge of the antecedents of childlessness is needed to guide early interventions and political policy in order to combat the challenge of childlessness faced by many countries today.

Studies that have investigated predictors of childlessness in men have predominantly investigated demographic factors. Among these factors education (Nisé, 2016; Nisé, Martikainen, Myrskylä, & Silventoinen, 2018; Trimarchi & Van Bavel, 2017) and income (Hopcroft, 2015; Keizer, Dykstra, & Jansen, 2008; Scheier & Carver, 1992) have been repeatedly associated with childlessness among men. However, there has not been much research on the psychological mechanisms underpinning these differences.

Intelligence is an important psychological property which correlates highly with both education (de Wolff & Van Slijpe, 1973; Sewell & Shah, 1967) and income (Ceci & Williams, 1997) and could help further the understanding how psychological traits influence reproductive outcomes.

Most of the research on intelligence and reproductive outcomes have been conducted on the association between intelligence and total number of children, and not on the differences between those with children and those that remain childless. Psychologically speaking, the difference between having children or not is more impactful than how many children one has. Parenthood is seen as the core of normal adult life (Dykstra & Hagestad, 2007) and not conforming to this family unit can have several adverse implications. The few studies that have examined the association between intelligence and childlessness among men find conflicting results (Kanazawa, 2014; Kolk & Barclay, 2019; von Stumm, Batty, & Deary, 2011). However, these studies do not properly take into account the potential indirect pathways between intelligence and childlessness through income, education and partnership histories. The present study aims to gain further insight into such pathways by exploring the mechanisms through which psychological traits such as intelligence influence reproductive outcomes using recent cohorts of men and including education, income and partnership history as potential mediators.

1.1 Childlessness

Childlessness is a demographic outcome with psychological consequences. In order to create a context of these psychological consequences, it is first necessary to review the demographic backdrop to the current childlessness rates across the world. During the last 60 years fertility rates have decreased all across Europe (Miettinen et al., 2015). In demography, this has been claimed to mark the change from the first to the second demographic transition (Lesthaeghe, 2010). The first demographic transition was the strengthening of the family as a societal entity from the end of the 19th to the middle of 20th century. There was a shift from marriage as means towards societal “climbing” to viewing marriage as a goal in itself and a pillar of the new welfare state. During the first demographic transition the average age at first marriage was declining and fertility rates increased across Europe, peaking after World War two with the “baby boomers”. The second demographic transition marked a departure from conservative family values and an increased focus on personal fulfillment outside of family

roles. Cohabitation and divorce rates increased in parallel with age at first birth and age at first marriage. Modern contraceptives have largely made childbearing a choice, and this choice is to a larger extent made with the self-fulfillment of the parents in mind.

As women have gained control of their fertility and are becoming less reliant on marriage to make their way in society, partnership could be seen as having become more of a mutual choice between men and women than before. Given this change in gender power dynamics, it is not a large leap to assume that men have to be chosen to a greater extent than before the second demographic transition. This may have contributed to the disproportionately large increase in childlessness among men relative to women (Jensen & Østby, 2014; Skrede, 2004).

While marriage is no longer the default organization of family life, the family is still the normative unit in today's society. Parenthood is seen as the core of normal adult life (Dykstra & Hagestad, 2007). Men who fall outside of the family unit can be ostracized and receive a host of negative outcomes. In this respect, it is not the difference between having one or two children that is important, but whether you have children at all. Furthermore, the family is an important structuring factor in a person's social network, and some evidence suggests that men are more dependent on their spouses for social support than women (Antonucci & Akiyama, 1987).

A distinction needs to be made between the concepts of childlessness, biological fertility and fertility. In the present study, childlessness will be used to describe whether a person has any biological children. Fertility is not used as a measure of a person's biological ability to have children, but rather as a measure of the total amount of children that a person has had. This distinction is important both for clarity of what is being measured and is also important in regards to potential predictors. Factors predicting childlessness and fertility might be quite different. For instance, in Finland, education was found to be positively correlated to fertility, but most strongly to the transition from zero to one child, meaning that it was more strongly tied to childlessness, than fertility as continuous outcome (Nisén et al., 2018). There are other examples where the same predictor would be positively associated with having at least one child, but be negatively associated with having many children. For instance, Barthold, Myrskylä, and Jones (2012) found that income both predicted not remaining childless, as well as having fewer children. This is important to keep in mind as I review the findings of the

studies presented below. The effects observed in fertility research might not be directly transferable to childlessness research.

When studying childlessness it is important to distinguish between those who are childless at any given time and those who remain childless their whole lives. For women, this is linked to menopause, when they become unable to bear children. Men, on the other hand, can biologically have children more or less their entire life (Kidd, Eskenazi, & Wyrobek, 2001). As such, the only perfect measure of childlessness in men is one conducted after their death. However, the likelihood of a hitherto childless man having his first child decreases drastically after a certain age. In a representative Swedish sample based on women and men born between 1945 and 1955, 96.5% of all men who had children at the time of measurement had the first one before 45 years of age (Fieder & Huber, 2007). In Norway, the rate of childlessness in men born in 1965 decreased from 22.09% at 45 years of age to 22% at age 50 (Statistics Norway, 2019). This makes 45 years of age a reasonable place to draw the line for when men will most likely remain childless throughout their lives if they have not already had children. Any such cut-off in age when measuring childlessness has both pros and cons. The earlier childlessness is measured the more relevant the findings are for the present society, while later measures decrease the likelihood that anyone in the sample will have children after childlessness was measured. For practical purposes and increased relevance, many studies adopt a convention of assuming that most men will not have their first child after the age of 40 or 45, with a few studies measuring childlessness after 50 (Charlie L. Reeve, Heeney, & Woodley of Menie, 2018). The present study measured childlessness at approximately 40 years. Using 40 years as a threshold has the benefit of studying cohorts that are not too far removed in age of the cohorts that are currently in the middle of their reproductive careers, which allows for a greater degree of relevance.

1.2 Intelligence

“Looked at in one way, everyone knows what intelligence is; looked at in another way, no one does” (Sternberg, 2000, p. 3). Sternberg wrote this in recognition of the fact that while most people have an idea of what intelligence is, it is rather hard to pin down scientifically. An editorial signed by 52 researchers defined intelligence as “a very general mental capability that, (...) reflects a broader and deeper capability for comprehending our surroundings — “catching on”, “making sense” of things, or “figuring out” what to do” (Gottfredson, 1997, p.

1). In order to measure intelligence, researchers and clinicians have attempted to split it into its constituent abilities. An expert group stated that the essential components of intelligence are abstract reasoning, problem-solving ability, capacity to acquire knowledge, memory, adaptation to one's environment, and mental speed (Snyderman & Rothman, 1987). Even though there is no strong consensus on a precise definition of intelligence, it appears we are able to measure it. Intelligence tests display good reliability and validity, indicating that they are reliably measuring a consistent latent psychological construct (Crawford, Obonsawin, & Allan, 1998; Laurent, Swerdlik, & Ryburn, 1992; Parker, Hanson, & Hunsley, 1992).

Intelligence has been found to predict diverse outcomes such as all-cause mortality (Calvin et al., 2010), academic performance (Chamorro-Premuzic & Furnham, 2008; Strenze, 2007), workplace performance (Hunter, 1986), income (Strenze, 2007), health (Gottfredson & Deary, 2004), criminal behavior (Loeber et al., 2012), to name some. Based on the concurrent and predictive validity of intelligence tests, most researchers operationalize intelligence as the sum score of an intelligence test. This sum-score is often said to be an estimate of the g-factor, a general factor underlying several different intellectual/cognitive abilities.

The present study used a total score of intelligence based on the intelligence test taken by all eligible men in Norway as a part of the evaluation for mandatory military service. This sum score has been found to correlate highly with another well-established intelligence test (Sundet, Tambs, Magnus, & Berg, 1988).

1.3 The link between intelligence and childlessness.

Different theories on the connection between intelligence and childlessness can be roughly divided into theories of direct or indirect effects. Every effect can be thought to be mediated in some way (Hayes, 2017). In the present study, direct effects are understood as intelligence having an effect on childlessness mainly through psychological mechanisms such as intelligent people being more flexible and thus being more likely to make the “unconventional” choice of childlessness, while indirect effects of intelligence on childlessness would be mediated through demographic outcomes such as education or income.

1.3.1 Direct effects

Kanazawa (2014) theorizes that a link between intelligence and childlessness can be explained by his Savanna-IQ interaction theory. Intelligence is seen as the trait which allowed the human species to adapt to new situations that were different from the situations where humans initially evolved. Our preference for evolutionary “familiar” strategies is moderated by intelligence in the sense that more intelligent people are more flexible in their problem-solving and thus will to a larger extent employ evolutionarily “unfamiliar” strategies. In regards to childlessness, not having children can safely be regarded as quite evolutionarily unfamiliar. Thus, the Savanna-IQ interaction theory would predict that more intelligent people to a larger extent would employ a “strategy” of childlessness. This theory mainly touches upon voluntary childlessness, and cannot account for involuntary childlessness, but may still inform our understanding of potential direct effects of intelligence on childlessness.

Kanazawa (2014) finds some support for the Savanna-IQ interaction theory for women, with intelligence predicting both higher rates of positive attitudes towards childlessness at a younger age and higher rates of childlessness above the age of 45. However, the same is not true for men where intelligence does predict espousal of positive attitudes towards childlessness, but not childlessness itself. This might mean that the Savanna-IQ interaction theory holds for attitudes, but not action. Thus, intelligent men might to a larger extent have positive attitudes towards childlessness, but these attitudes do not translate into behavior, as women's attitudes about childlessness, but not men's, predict whether any given couple end up with children.

Another way in which intelligence could be more directly related to childlessness is through so-called slow life stories, or the k-factor. A higher k-factor means slower life stories often characterized by larger restraint, more future oriented behavior, and narrow rather than wide mating strategies (Rushton, 1985). Rushton (1985) further predicted that slower life histories should correlate with intelligence. In addition, the k-factor has been found to positively predict fertility in both the US and Sweden (Michael A. Woodley of Menie et al., 2017). However, it does not appear that intelligence consistently predict the k-factor (Woodley, 2011) when examined empirically. Thus, it appears that this seemingly intuitive association between intelligence and reproductive behavior is not empirically founded.

1.3.2 Indirect effects

Indirect effects of intelligence on childlessness would be intelligence affecting demographic factors which in turn affect childlessness. It has been well established that intelligence is highly predictive of both education (Deary, Strand, Smith, & Fernandes, 2007; Jencks, 1979; Roth et al., 2015) and income (Strenze, 2007). Both these factors have also been shown to be protective factors against childlessness for men (Barthold et al., 2012; Hopcroft, 2015; Keizer et al., 2008; Nisén et al., 2018; Trimarchi & Van Bavel, 2017). Therefore, even if there is no direct effect of intelligence on childlessness, intelligence could still have a total effect on childlessness, mediated by the above factors.

Partnership formation is also a potential pathway for an indirect effect of intelligence on childlessness that has not yet been investigated thoroughly. Most children are born within established partnerships (Kennedy & Bumpass, 2008; Laplante, Castro-Martín, Cortina, & Fostik, 2016), and the extent to which men manage to form these partnerships are important to whether they have children. If more intelligent men have a higher propensity to form partnerships this could be an important indirect effect of intelligence on childlessness. For instance, studies from an evolutionary psychology tradition suggests that, relatively speaking, social status is a more important factor for women than men when selecting a partner (Buss, 1989; Buss, Shackelford, Kirkpatrick, & Larsen, 2001). Social status has been found to be associated with intelligence (Strenze, 2007). More knowledge is required about these mediating variables in order to further disentangle the potential mechanisms of the association between intelligence and childlessness among men.

1.4 Intelligence as a predictor of childlessness

As discussed above, there are several reasons intelligence could be related to childlessness, through either direct or indirect pathways. In order to investigate the presence of indirect and direct effects of intelligence on childlessness, it is first necessary to examine whether intelligence is at all associated with childlessness.

Intelligence has been shown to be associated with higher age at first birth for both women and men (Heck, Schoendorf, Ventura, & Kiely, 1997; Neiss, Rowe, & Rodgers, 2002), and thus measuring childlessness before the majority of the sample have finished their reproductive careers might result in a positive effect of intelligence on childlessness being overestimated.

For instance, one study on intelligence and childlessness found a positive association between intelligence and childlessness, but measured childlessness when the participants were at an average age of 29 (Charlie L Reeve, Lysterly, & Peach, 2013). Because of the age childlessness was measured at, it was not possible to establish whether this study measured remaining childless throughout the lifespan or simply delayed transition into fatherhood.

Several studies have investigated the association between intelligence and fertility, but very few have studied the association between intelligence and remaining childless. To the best of my knowledge, three studies to date have examined the association between childlessness measured after the age of 40 and intelligence, and they have conflicting results.

Kanazawa (2014) studied a cohort of all men and women born in Great Britain during a chosen week in March 1958. The participants were 47 years old when childlessness was measured. Intelligence was measured at the age of 7, 11 and 16. Kanazawa performed a factor analysis at each measurement. He used the latent intelligence scores for each measurement and performed another factor analysis on the latent factor for each year of measurement. The latent intelligence scores from this second factor analysis was used as a measure of childhood general intelligence, which was used to predict childlessness. He found no association between intelligence and childlessness for men.

The two other studies both find an effect of childlessness, but in opposite directions. In their study of men and women from the Aberdeen Children of the 1950s study, von Stumm et al. (2011) measured childlessness when the participants were between 46 and 51. Intelligence was measured when the participants were 11 by tests of verbal reasoning, arithmetic and English. They found an increased risk of childlessness associated with higher intelligence for men. In contrast, Kolk and Barclay (2019) found a decreased risk of childlessness associated with higher levels of intelligence in their cohort consisting of all men born in Sweden between 1951 and 1967, using intelligence tests administered as a part of mandatory military conscription as a measure of intelligence. They found that this effect was due to the participants with lower levels of intelligence having a higher risk of remaining childless, while there was less of a difference between intelligence scores in the upper half of the distribution.

When comparing research results it is important to consider the methodology of the studies, which indicate important differences. Both Kanazawa (2014), who found no association, and

von Stumm et al. (2011), who found a positive association, are based on survey data. By survey data, I mean data based on a sample of participants who voluntarily, either through their own consent, or the consent of their parents, filled in a questionnaire, or participated in another form of measurement. On the other hand, Kolk and Barclay (2019), who found a negative association is based on register data provided by Statistics Sweden. Register data is data on the entire population of a country that is collected irrespective of the participants participation in research projects.

Compared to studies based on register data, studies based on survey data are prone to lower response rates as well as dropout. Previous research has established that people who readily responds to surveys generally have higher socioeconomic status and more education (Purdie, Dunne, Boyle, Cook, & Najman, 2002; Voigt, Koepsell, & Daling, 2003). Less education and poorer health is also more common among those who drop out of longitudinal surveys (Young, Powers, & Bell, 2006). Furthermore, lower childhood intelligence and less education has been shown to independently predict dropout of Britain's largest lifetime development study (Stafford et al., 2013). A review confirms the findings of lower education and lower socioeconomic status among dropouts of longitudinal studies (Keeble, Baxter, Barber, & Law, 2015). Kolk and Barclay (2019) found that the positive effect of intelligence on childlessness in their sample was larger among those with lower levels of education, which may indicate that having less participants with lower levels of education can underestimate the effect of intelligence on childlessness. By employing register based studies rather than survey based studies, these potential issues are avoided.

It is hard to know whether sample bias influenced the results of Kanazawa (2014) and von Stumm et al. (2011), but it may be part of the explanation for why Kolk and Barclay (2019) found a negative association between intelligence and childlessness while the other studies found either a positive association or no association. It is also possible that these differences are the result of differences between the countries in which these studies were conducted. Either way, the fact that Kolk and Barclay (2019) included every Swedish male in the cohorts they studied, makes their results hard to refute. With only three studies on intelligence and childlessness, and all of them with different results, it is hard to make any conclusions about the nature of this association. More research is required to produce a better understanding of these diverging results. In lieu of more research on intelligence on childlessness, the literature on intelligence and fertility may help shed some light on these conflicting results.

A meta-analysis of studies on the association between intelligence and fertility found a general negative association between intelligence and fertility for men (Charlie L. Reeve et al., 2018). However, there are inconsistencies between the studies included in the meta-analysis with six of them finding no association between intelligence and fertility (Bajema, 1968; Chen, Chen, Liao, & Chen, 2013; Conrad & Jones, 1932; Meisenberg & Kaul, 2010; Meisenberg, Lawless, Lambert, & Newton, 2006; R. Willoughby, 1928), and seven of them finding a negative association (Higgins, Reed, & Reed, 1962; Lynn & Van Court, 2004; Vining Jr, 1982, 1995; Wang, Fuerst, & Ren, 2016; R. R. Willoughby & Coogan, 1940; Michael A Woodley of Menie, Figueredo, Dunkel, & Madison, 2015; Michael A. Woodley of Menie, Schwartz, & Beaver, 2016).

As fertility was not measured at the same age in these studies, the authors of the meta-analysis ran an analysis to see whether the age fertility was measured at made a difference. The analysis revealed that the effect was larger in the studies that measured fertility before 40. It was not reported whether the effect was still significant in the subset of studies that measured fertility later in life (Charlie L. Reeve et al., 2018). Even though this analysis was on fertility, it still indicates that the age childlessness is measured at can make a large difference. Further support for the need to take into account the age childlessness is measured at comes from the Swedish register study mentioned above. Kolk and Barclay (2019) found that an increased risk of childlessness associated with the highest intelligence scores became apparent if childlessness was measured before 40, but that this effect disappeared as childlessness was measured at older ages.

All of the abovementioned studies have studied a linear effect of intelligence on fertility. The presumption of the linearity of this association could be questioned. Another study examined the presence of non-linear quadratic effects of intelligence. (of Menie et al., 2016). This method allows us to examine whether intelligence affects fertility differently at the extreme ends of the spectrum. They found a negative quadratic association between intelligence and fertility, meaning that both low and high intelligence were detrimental to fertility. While the linear effects were the strongest, this finding may still suggest that non-linear associations between intelligence and fertility could be present.

Even though the meta-analysis reported a negative association between intelligence and fertility, this association may no longer be present in younger cohorts. Meisenberg (2019) found no association between intelligence and fertility for men above 44 born between 1951

and 1973, while a negative association between intelligence and fertility was present in older cohorts. If this same trend is present for the association between intelligence and childlessness it shows the necessity of studies on intelligence and childlessness in younger cohorts.

Taken together it appears that the literature on fertility and intelligence is more consistent than the literature on intelligence and childlessness. The literature on the association between intelligence and fertility generally finds a negative association or no association.

Based on the literature on intelligence and fertility a new look can be made on the literature on intelligence and childlessness. First, the literature on intelligence and fertility further identifies the Swedish study by Kolk and Barclay (2019) as an outlier where higher intelligence reduces the risk of childlessness. No other study has found such an association, but, as I have pointed out above, this could in part be explained by the fact that this is the only study to date based on register rather than survey data. Second, the results of no association between intelligence and childlessness found by Kanazawa (2014), and the increased risk of childlessness associated with intelligence found by von Stumm et al. (2011) are both in line with the literature on intelligence and fertility in general. Still, it is not a given that the association between intelligence and childlessness should be the same as the association between intelligence and fertility. Given the methodological rigor of Kolk and Barclay (2019) it is hard to dismiss it as a simple outlier in an otherwise fairly consistent field. These conflicting results and unanswered questions illustrates the need for further studies on intelligence and childlessness, ideally on cohorts that are as young as possible while remaining reasonable certain that they have completed their reproductive careers.

1.5 Direct and indirect associations between intelligence and childlessness

Based on the review of the literature it appears that an association between intelligence and childlessness exists. However, the mechanisms of this association are still unknown. Is the association predominantly direct or indirect? In order to begin to answer this question it is necessary to look at potential mediating variables, which may drive an indirect effect of intelligence on childlessness.

An indirect association between intelligence and childlessness is the same as a mediated association. The seminal paper by Baron and Kenny (1986) introduced four steps to evaluate

the presence of direct and indirect effects through mediation analysis. In mediation analysis, a mediated effect and an indirect effect is the same. The first step is to establish that the predictor is associated with the outcome; in this case, that intelligence is associated with childlessness. The second step is to establish that the predictor is associated with the mediator, which in this case would mean that intelligence is associated with any potential mediators that could transmit an indirect effect of intelligence on childlessness. The third step is to establish that the mediator is associated with the outcome, also when the predictor is controlled for, and the fourth step is to establish that the effect of the predictor on the outcome changes when the mediator is included. In this case, the potential mediators need to be associated with childlessness, even when intelligence is controlled for, and the effect of intelligence on childlessness needs to change when the mediators are included. If the effect disappears altogether, then the total effect of intelligence on childlessness is completely mediated, meaning there is no direct effect. If the effect of intelligence on childlessness is maintained at a lower level when the mediators are included, the effect is partially mediated, meaning both indirect and direct effects are at work. If the effect of intelligence on childlessness is unchanged, it may indicate the presence of only direct effects.

There are some cases in which the direct effect of a predictor on its outcome is positive while the indirect effect is negative, or the other way around. In these cases, the strength of the direct effect would increase when the indirect effect is included. This form of association is either called inconsistent mediation or a suppressor effect depending on whether this effect is part of the main analysis, or simply controlled for (MacKinnon, Krull, & Lockwood, 2000). MacKinnon et al. (2000) maintain that the process for investigating inconsistent mediation is the same as the process for investigating ordinary mediation. In the present study, both mediation effects and inconsistent mediation effects are examined in order to gain an as complete as possible understanding of the direct and indirect effects of intelligence on childlessness.

In order to identify potential mediating factors of an indirect association between intelligence and childlessness it is useful to look to what is already known about predictors of childlessness. Among the predictors of childlessness that have been studied in men, two domains of predictors become apparent: partner formation and socioeconomic factors.

1.5.1 Partnership history

The association between relationship history and childlessness

Transitions into parenthood can occur both outside and inside of partnerships, but it is far more common inside of them (Kennedy & Bumpass, 2008; Laplante et al., 2016). A Dutch study found that years without a partner is positively correlated with childlessness in men (Keizer et al., 2008). The fact that entering into a partnership is an important step towards having children is unsurprising. Of larger interest is perhaps the relationship history pathways into childlessness.

Jalovaara and Fasang (2017) found that 45% of those who were childless at 42 had never been in a co-residential relationship. Raab and Struffolino (2019) included those who had so-called living apart-together (LAT) relationships, where two people are romantically involved without living together. They found that 39.3% of those who remained childless had never been in a romantic relationship, while 18.8% had been in LAT relationships. Furthermore they found that 69% of those who had never been in a romantic relationship were male. The fact that men were overrepresented in the single group, makes the case that relationship history is especially important in the study of childlessness among men. These studies show that not only are childless men more often single, many of them have never been in a relationship their entire life. The majority of childless men in both of these studies have never been cohabiting or married. Given these results, it is natural to wonder why some men end up in a relationship, and whether intelligence might be one factor influencing who ends up in relationships.

The association between intelligence and relationship history

Selection into romantic partnerships have previously been linked to prosocial behavior (Stavrova & Ehlebracht, 2015), physical attractiveness (Margana, Bhogal, Bartlett, & Farrelly, 2019), income (Asendorpf, Penke, & Back, 2011) and education (Fisman, Iyengar, Kamenica, & Simonson, 2006; Wiik & Dommermuth, 2014). Prosocial behavior (Meeks Gardner, Powell, & Grantham-McGregor, 2007), income (Strenze, 2007) and education (Roth et al., 2015) have all been associated with intelligence as well. Based on these findings, it could be expected that there is an effect of intelligence on whether or not people end up in

partnerships At the very least there should be indirect effects mediated through the above factors. Indeed, intelligence has been found to predict total years married (Meisenberg, 2010).

However, a recent study did not find an association between measured intelligence and mate-preference (Gignac, Darbyshire, & Ooi, 2018). The same study failed to demonstrate an association between women's self-reported preference for intelligent mates and their actual preference for men with a higher measured intelligence. Thus, findings of a direct mate preference for intelligent men among women are unclear.

Based on potential direct and indirect pathways between intelligence and mate-preference, as well as the clear effect of partnership history on childlessness, there are reasons to believe that partnership history is an important factor that may mediate an indirect effect of intelligence on childlessness.

The association between intelligence and childlessness through relationship history

The final step is to examine whether the association between intelligence and childlessness changes when relationship history is included in the analysis, as well as confirming the association between relationship status and childlessness when intelligence is controlled for.

Two of the studies on childlessness and intelligence included measures of relationship history. Kanazawa (2014) included total number of marriages but this was not significantly correlated with childlessness. von Stumm et al. (2011) controls for marital status at a single timepoint, and their finding of higher intelligence conferring an increased risk of childlessness is maintained when these factors are controlled for. von Stumm et al. (2011) did not report whether the association between intelligence and childlessness changed when marital status was included, or if marital status had an effect on childlessness when intelligence was included in the analysis. These two studies are the only studies on childlessness and intelligence to include relationship history.

None of the two studies on childlessness and intelligence that have included some measure of partnership history show signs that the association between intelligence and childlessness could be mediated by relationship history. However, looking to the literature on intelligence and fertility, one study included relationship history in the models used to estimate the association between intelligence and fertility. Meisenberg (2010) found a positive mediated

effect of intelligence on number of children through total years married for white men. Although they did not make an estimate of how much of the effect of intelligence on fertility was mediated, they found that the effect was maintained, but reduced, indicating that at least some of the effect of intelligence on fertility operated indirectly through relationship history.

Based on these findings it is hard to draw any conclusions about whether relationship history can act as a mediator between intelligence and childlessness. The literature on intelligence and childlessness does not appear to offer any support for such a mediated association, but these studies have only included whether participants were married or how many times they had been married. Meisenberg (2010) found evidence of a mediated effect of intelligence on fertility through total years married, but it is not certain whether these results can be generalized to childlessness.

Furthermore, data on relationship history was limited to marital status in the previous studies. Given the increase of children born into unmarried cohabiting unions, not including cohabiting relationships as a context of producing offspring might not fully reflect the effect of relationship status on childlessness.

1.5.2 Socioeconomic factors

Socioeconomic status (SES) is a way to sum up the advantages a person enjoys in society, relative to others. It often includes measures of education, income and occupational position. Lower SES has been related to a host of different negative life outcomes such as increased mortality (Anderson, Sorlie, Backlund, Johnson, & Kaplan, 1997; Cubbin, LeClere, & Smith, 2000; Stringhini et al., 2017), poorer mental health (Callan, Kim, & Matthews, 2015; Garrison & Rodgers, 2017; González, Swanson, Lynch, & Williams, 2016) and poorer somatic health (Fitzpatrick et al., 2015; Lago et al., 2018; Williams, Priest, & Anderson, 2016). SES has also been connected to a higher rate of childlessness among Norwegian men (Lappegård & Rønsen, 2013). Income and education are of particular as intelligence has been found to be predictive of both education (Deary et al., 2007; Jencks, 1979; Roth et al., 2015) and income (Strenze, 2007). The current study will thus focus on income and education in terms of their association with intelligence and childlessness in order to assess them as potential mediators of an indirect effect of intelligence on childlessness.

Income

Sociobiological theory predicts that status-markers like income should be positively associated with reproductive success, as they give access to both partnerships and the resources that enable individuals to enter into parenthood (Wilson, 2000). This appears to be the case for men. A Dutch study found that higher income is positively associated with fertility for men (Keizer et al., 2008). Yet another study found that income is positively associated with fertility for men across all levels of education. (Hopcroft, 2015). However, income may not have the same influence on fertility and childlessness for men. Barthold et al. (2012) analyzed childlessness and fertility separately and found a split effect. Their study found that men with higher income were less likely to remain childless, but men with higher income that had children were likely to have fewer children than their lower income counterparts. This further illustrates the importance of separating the prediction of childlessness and fertility. Furthermore, this split effect may help nuance the results of the abovementioned studies who have simply examined fertility. In addition, the role of income as a mediator of an indirect association between intelligence and reproductive behavior may be different depending on whether fertility or childlessness is being examined. As mentioned income has also been associated with intelligence (Strenze, 2007), and as such can act as a mediating variable.

Thus, it appears that income is both associated with intelligence and childlessness. Furthermore, income appears to be positively associated with intelligence and negatively associated with childlessness. If this is the case, it would be expected that income could act as mediator of a negative indirect association between intelligence and childlessness. If a total positive association exists between intelligence and childlessness, income would act as an inconsistent mediator.

Kanazawa (2014) controlled for income at the age of 23. Higher income was associated with a reduced risk of childlessness when all other factors were controlled for. However, Kanazawa (2014) did not find a total effect of intelligence on childlessness, and so the criteria for mediation are not met. This is the only study of childlessness and intelligence to have included income.

While the childlessness literature does not find evidence of income mediating the effect of intelligence on childlessness, two studies on intelligence and fertility finds evidence of this

mediation. Meisenberg (2010) found a negative mediated effect of intelligence on number of children through income for white men, but not black men. The other study to find a mediated effect of income is on the same data, but divided the ethnic groups into white, black and Hispanic (Meisenberg & Kaul, 2010). They found a significant negative effect of intelligence on fertility only among Hispanic married men, and this effect was completely mediated by income. It is not clear why these studies found a mediated relationship for some ethnic groups, but not others. While none of these studies provided estimations or significance tests of their indirect effects, they both seem to provide support for some of the effect of intelligence on fertility being mediated by income.

All of the studies of intelligence and fertility that have included income have found that income is significantly associated with fertility, even when intelligence is controlled for. Furthermore, all of the studies that found an association between intelligence and fertility and included income found that income mediated at least part of the association. However, as seen above, there are indications that income might have different effects on fertility and childlessness (Barthold et al., 2012), and thus the mediated effect of intelligence on childlessness through income is still unclear, and in need of further study.

Education

The predictive value of education on childlessness varies across studies. Some studies find no association between education and childlessness for men. In Sweden, higher education from traditional universities were not found to be associated with childlessness for men (Chudnovskaya, 2019), while a Czech population study found a clear positive association between education and childlessness measured after 40 for older cohorts, but not for younger cohorts (Kyzlinková & Šťastná, 2018). On the other hand, a Finnish study based on register data found a negative association between education and childlessness for men (Nisén et al., 2018). This was also the case for a cross-sectional study with data from 10 different European countries, which found a negative effect of education on childlessness for men (Trimarchi & Van Bavel, 2017). Jalovaara et al. (2018) replicates these findings for Norway, Sweden and Denmark.

The research on the association between childlessness and education appears somewhat conflicted, but on the whole it seems that men with higher education are generally at lower risk of childlessness. As touched upon above, education is also positively associated with

intelligence (Deary et al., 2007; Jencks, 1979; Roth et al., 2015). Thus, it would be expected that to the extent that education acts as a potential mediator of an indirect effect of intelligence it would mediate a negative effect of intelligence on childlessness.

In the literature on intelligence and childlessness Kanazawa (2014) and Kolk and Barclay (2019) included measures of education. Kanazawa (2014) did not find an association between education and childlessness when intelligence was controlled for. Kolk and Barclay (2019) found that controlling for education did not diminish the effect of intelligence on childlessness. However, they found a larger effect of intelligence on childlessness within lower educational levels, and a smaller effect among the more highly educated, which might indicate that education could act as a moderator rather than a mediator.

Neither study found evidence of an indirect effect of intelligence on childlessness mediated through education. In order to find further clues of such a potential indirect effects I look again towards the literature on intelligence and fertility. As before, caution is needed when generalizing these findings to the effect of intelligence on childlessness.

Chen et al. (2013) controlled for education in their study of the association between intelligence and fertility. They did not find a significant correlation between intelligence and fertility, or education and fertility. However, their analyses were based on a sample of only 40 men, and thus probably suffered from power issues, which means that a relationship may exist that they did not have sufficient power to reveal. Meisenberg (2019) included income and education in his analysis, but found no effect of intelligence on fertility in younger cohorts with completed fertility, neither before nor after education and income was controlled for. Income had a positive association with fertility, while education was not found to be associated with fertility. These two studies do not shed further light on a potential mediated relationship between intelligence and fertility, as none of them found a significant effect of intelligence on fertility for men in the first place. Meisenberg (2010) included education among other potential mediating variables in order to investigate mediated indirect effects of intelligence on fertility, as well as investigating the direct effect of intelligence on fertility. He did not find an association between education and number of children when intelligence was controlled for. Another study on the same data which made separate analyses for married and single participants, found a negative effect of intelligence on number of children through education for single men, but not married men (Meisenberg & Kaul, 2010).

Michael A. Woodley of Menie et al. (2016) found a negative relationship between intelligence and fertility that was fully mediated by education. However, as they measured fertility at an average age of about 30, it is not clear whether they have measured the total amount of children or a delayed transitions into fatherhood .

The research on fertility and intelligence does not offer clear support of an indirect association between intelligence and fertility mediated by education. One study found that there may be an indirect association between intelligence and fertility mediated by education among single men, but not married men. Still, the results are conflicted, and the majority of studies on fertility and intelligence do not find an association between education and fertility. These results may provide additional support that an indirect association between intelligence and childlessness mediated by education does not exist.

1.6 Summary

As we have seen, there is support for an association between intelligence and number of children for men. There is less research available on the association between intelligence and childlessness, and the results are conflicted. Furthermore, we have seen that relationship history, income and education are all associated with both intelligence and childlessness. However, the association between childlessness and both relationship history and education is not consistently found in the few studies on intelligence and childlessness, nor the studies on intelligence and fertility. Income was the factor that was most consistently associated with reproductive outcomes, and was also found to mediate an indirect effect of intelligence on fertility in all studies that found an association between intelligence and fertility. No study, except one that studied childlessness 10 years before participants could be reasonably assumed to have completed their reproductive careers (Michael A. Woodley of Menie et al., 2016), found a relationship between intelligence and any reproductive outcome which was completely mediated by another factor.

In summary, it seems like there is some evidence of both direct and indirect effects of intelligence on fertility, but not much evidence exists for the direct or indirect effect of intelligence on childlessness. There are few studies on intelligence and childlessness, and more evidence is needed to conclude. Meisenberg (2010) finds that including more dynamic measures of relationship history may reveal greater effects. Meisenberg (2019) also illustrates

the need to examine the link between intelligence and childlessness in as young cohorts as possible, given that the relationship between intelligence and fertility seems to be changing. Kolk and Barclay (2019) challenges the results found in survey research mainly in the US and the UK, illustrating the need for research on intelligence and childlessness in other countries.

The present study examined the association between childlessness and intelligence based on a mix of survey and register data in Norway. To the best of my knowledge, it is the first study on intelligence and childlessness, or fertility for that matter, to include a measure of relationship history encompassing early informal romantic relationships, as well as later history of cohabitation and marriage. Income and education were also included as potential mediators in addition to relationship history. Furthermore, the study includes the most recent cohort of men that have been examined in published studies to date that have measured childlessness after 40 years of age, as far as I know.

1.7 Research questions and hypotheses:

The literature reviewed above has revealed conflicting findings about the association between intelligence and childlessness with one study finding a positive association, one study finding no association and yet another finding a negative association. The literature on intelligence and fertility finds either a negative association with number of children or no association. Even though the one study that found a negative association between intelligence and childlessness is the only study to have done so, it was conducted on a dataset encompassing every Swedish male born within a large period of time (Kolk & Barclay, 2019). It is also the study to have investigated the youngest cohorts as well as the study that has been conducted in the most similar demographic context to Norway. Because of these factors, even though it is against the general trend of the literature, I hypothesize that intelligence should be negatively associated with childlessness, before any potential mediators are taken into account.

Income, education and relationship history have been considered as potential mediating variables of an indirect effect of intelligence on childlessness. Income appears to be the variable most robustly associated with childlessness in the literature reviewed. I hypothesized that income should mediate a negative effect of intelligence on childlessness. Education has not been as robustly associated with reproductive outcomes in the literature reviewed. The

findings are conflicted in the studies which focus on education and childlessness and almost no studies find a connection between education and fertility in the literature on intelligence and fertility. However, education might have different effects on childlessness than fertility. Because of the conflicting evidence, I do not form a hypothesis about the indirect effect of intelligence on childlessness through education. Finally, relationship history has not previously been shown to mediate an indirect effect of intelligence on childlessness, but have been shown to have an indirect positive effect on number of children. Due to the conflicting nature of the reviewed literature, no hypothesis is formed about whether relationship history mediates an indirect effect of intelligence on childlessness.

Even though I hypothesized that some of the effect of intelligence on childlessness is indirect through other factors, only one previous study has found that intelligence is completely mediated by any of these factors, and this study measured childlessness far before the participants had reasonably completed their reproductive careers. Thus, I hypothesize that a direct effect of intelligence on childlessness will also be present, even after controlling for the included mediators.

2 Method

2.1 Procedure and participants

This study was based on data from the Young in Norway Study, which has been linked to the registry of intelligence test performed on all young men in Norway in the process of conscription into mandatory military service at age 19. The Young in Norway study collected data at four different timepoints: 1992 (T1), 1994 (T2), 1999 (T3) and 2005 (T4) (see von Soest, Wichstrøm, and Kvalem (2016)). The initial wave of the study recruited students in grades 7 through 12 from junior and senior high schools in Norway. The first wave contained 12,287 participants and had a response rate of 97%.

The schools that the participants were recruited from were selected from a register of every school in Norway. The sample was stratified according to geographic region and school size, which in Norway is closely related to the degree of urbanization. In order to ensure that the probability of being selected to participate was the same for all students in Norway, the sampling probability of each school was proportional to the number of students enrolled at the school.

For the second wave of the study, the students who still attended the same school received the questionnaire in school, while those who had changed or left school received them by mail. Due to comparatively lower response rates by those who received the questionnaire by mail, they were excluded from the study for the two remaining waves, in order to reduce the chance of factors affecting dropout affecting the analyses. The participants who received the questionnaire in school had a response rate of 92% ($n = 3,844$). Because the initial consent did not include more than two waves, new informed consent had to be collected at T2, with 91% ($n = 3,507$) consenting to two additional follow-ups. The third and fourth waves had comparatively lower response rates with rates of 84% ($n = 2,924$), and 82% ($n = 2,890$) respectively. At the fourth wave the participants were asked for their consent to link their data to several registers, with 90% ($n = 2,606$) giving their consent, 1,147 of these being boys, two of which later withdrew their consent to data linkage.

The Young in Norway participants were linked to two different registries in 2017. A test measuring cognitive abilities is part of the recruitment to mandatory service in the Norwegian

armed forces. The result of this test was linked to the study by their social security numbers. An additional 62 participants were excluded due to missing intelligence test scores. The study participants were also linked to the Historical Event Database (FD-Trygd) of Statistics Norway. This database includes details on demography, social conditions, social security, employment, income and wealth. The final number of participants in the present study counted 1,083 men

2.2 Measures

Childlessness

Childlessness was defined as remaining without registered offspring in the Statistics Norway (SSB) registry at the final point of measurement (2017). At the final point of measurement the participants were between 38 and 44. Childlessness was dummy-coded as a dichotomous variable with being childless coded as 1 and having any amount of children being coded as 0. For the main analysis, participants who had adopted children were excluded, as the predictors of adopting a child could be different to the predictors of producing biological offspring.

Intelligence

The neuropsychological test battery administered as a part of the process of conscription into mandatory service in the Norwegian armed forces contains three tests measuring different cognitive domains. The tests are timed and consist of Arithmetic, Word Similarities and Figures. Arithmetic is similar to the WAIS-test of arithmetic, and measures basic arithmetic ability as well as reasoning ability. In the Word Similarities test subjects are presented one word after the other and are asked to find the synonym of the word among eight alternatives. Figures was constructed to be similar to Ravens Matrices, and consists of several series of figures where subjects are asked to identify the logical continuation or missing link in each series. The reliability of these sub-tests has been estimated by test-retest correlations in the mid-1950s and these are .84, .72 and .90 for Arithmetic, Figures and Word Similarities respectively (Sundet et al., 1988). Cronbachs alpha for these same tests have been found to be .81, .80 and .90 respectively (Sundet, Barlaug, & Torjussen, 2004). In order to estimate a general ability score, the raw score of the sub-tests are transformed into T-scores (mean = 50, SD = 10). The T-scores are combined and turned into a stanine scores, a scale with an average

of 5, a range from 1-9 and a standard deviation of 2. The test has good concurrent validity with correlations of .73 with WAIS IQ in a small sample of 48 participants (Sundet et al., 1988).

Age

Age was calculated based on year of birth reported at T1. Because this was a non-random sample recruited from a school setting, participants younger than 38 ($n = 2$) and older than 44 ($n = 13$) were excluded. These participants were excluded because they were of an atypical age for the level of education they were recruited from.

Age at first child

Age at first child was calculated for all participants who had had children based on data from the national registry.

Income

Income was measured at two time points. The first time as part of the fourth wave of the Young in Norway study when the participants were in their late twenties, and the second time in 2014 based on the national tax register when the participants were in their mid to late thirties. For the second measurement, 2014 was the latest time point at which income information was available. For both time points, income was measured in thousands of Norwegian kroner.

Two different time points were selected because income at these two times could be dependent on different factors. For instance, in their late twenties, there might be no effect, or a negative effect of higher education, because some participants undergoing higher education would not have entered, or barely entered full time occupation. At the later time point, a positive association with education might be apparent, as the time spent in the workforce starts to even out between participants with higher and lower education. It is also possible that the effect of intelligence on income might be accumulative over time, as work performance over time grants access to promotions or new opportunities. The income variables were standardized in order to simplify interpretation.

Education

Highest level of completed education was measured in 2017 based on the national registry of Norway. Having completed only mandatory schooling was coded as 0, having completed high school was coded as 1, a bachelors degree or corresponding higher education was coded as 2, and a masters degree or corresponding higher education was coded as 3.

Relationship history

Three different measures of relationship history were used: whether participants had ever been in a relationship by their late twenties, total years spent in a relationship between T3 and T4 (taken from the questionnaire self-reports), and total years spent cohabiting or married between T4 (2005) and 2017 (taken from the Statistics Norway national registry).

Three different measures of relationship history were used because they were thought to express different things. While, later relationship history may be highly convolved with childlessness, earlier relationship history was used to gain an understanding of participants' tendencies to form romantic relationships independent of childrearing.

2.3 Ethical considerations

Written and spoken consent was collected from all participants at the start of the Young in Norway study. For participants below the age of 16, consent was also collected from their parents. The study was approved by Norwegian Data Inspectorate and the Regional Committee for Medical Research Ethics.

2.4 Statistical analyses

I first present descriptive statistics of all study variables. These are presented as averages and standard deviations. Differences between the childless and non-childless participants were examined and tested for statistical significance. Where the variable in question was a continuous variable, a t-test was performed. Where the variable was a frequency, a chi square test of independence was used. The rate of childlessness for each stanine intelligence score was calculated and graphed out in order to show the general trend of this association, with the added benefit of being able to suggest the presence of non-linear associations if any exist.

Initially the correlations between the study variables were examined using Pearson's r in order to give a rough idea of the interdependencies of the study variables as well as investigate the presence of multicollinearity, which may be a threat to the validity of further regression analyses.

Given the absence of multicollinearity, a preliminary binary logistic regression with childlessness as the criterion variable and intelligence as the predictor was performed in order to examine whether a general association exists.

In order to examine whether a mediated effect might exist, it is necessary to satisfy four conditions, or "steps" (Baron & Kenny, 1986). The first is whether the predictor is associated with the outcome, often called the "total effect". In this case this is examined by running a logistic regression analysis with intelligence as the predictor and childlessness as the outcome. The second step is to establish that the predictor is associated with any potential mediators. In this analysis, this step was performed by running additional regression analyses with intelligence as the predictor and the potential mediators as the outcome variables. The third step is to establish that the mediators are associated with the outcome when the predictor is controlled for. The fourth step is to examine whether the effect of the predictor on the outcome changes when the mediators are controlled for. Step three and four are evaluated in the same analysis. In this final analysis, the potential mediators are included in a logistic regression model. The association between the mediators and childlessness is used to evaluate step three, and the association between intelligence and childlessness is used to evaluate step four. Only the potential mediators that satisfied step two are included in the final analysis. Age was controlled for in all analyses as a potential confounding variable.

Baron and Kenny (1986) describe an approach to estimate how much of an effect is mediated by a potential mediator by calculating the indirect effect as a fraction of the total effect. If this fraction approaches one, it may indicate complete mediation. However, when logistic regression is used, this becomes more complicated. In logistic regression, the variables are not on the same scale when they are used as predictors, as when they are used as an outcome. Thus, the different paths in the mediation analysis cannot be directly compared. MacKinnon and Dwyer (1993) have developed a solution to this problem where the paths in the mediation model are standardized to allow an estimation of the indirect effect.

Kenny and Baron's four steps are useful in determining the association between each variable in a mediation because they can aid interpretation of the mediated effect. However, newer thinking on mediation analyses have shifted towards evaluating mediation by performing inference statistics on the indirect effect (Hayes, 2017). Because the outcome (childlessness) and one of the potential mediators ('ever been in a relationship') were dichotomous, the z-mediation inference statistic described in Iacobucci (2012) was computed, as is recommended in Iacobucci (2012). This inference statistic is computed by estimating the paths from Baron and Kenny's step two (a) and three (b) and dividing these by their respective standard errors (S_a and S_b). The product of these standardized estimates are then divided by their collected standard error in order to produce a z-value. If this z-value is larger in absolute size than 1.96, the indirect effect is significant at a $p = 0.05$ level. The formula for this test is given below.

$$Z_{mediation} = \frac{Z_a Z_b}{\hat{\sigma}_{Z_{ab}}} = \frac{\frac{a}{S_a} \times \frac{b}{S_b}}{\sqrt{Z_a^2 + Z_b^2 + 1}}$$

Given the absence of a linear effect of intelligence on childlessness, two additional analyses were performed. First, an analysis that included a quadratic term in order to examine whether a different association might exist at the extreme ends of the intelligence spectrum. Secondly, a logistic regression analysis was performed where intelligence was treated as a categorical variable in order to examine whether an elevated risk of childlessness exists for some stanine intelligence scores relative to others. For both of these analyses the same mediation analysis as described above was performed.

3 Results

3.1 Descriptive statistics

Table 1 provides an overview of the means or frequencies of the relevant study variables. The table shows that intelligence scores differ slightly from the national norms. The test scores are normed to have an average score of 5 and a standard deviation of 2. In the present study, the average is higher and the standard deviation is smaller than the norms for the test. However, research on the secular trends in the intelligence scores of the cohorts undergoing the conscription battery shows that the average scores are changing (Sundet et al., 2004). In fact, the national averages for the cohorts in the present study have been found to be approximately between 6.1 and 6.3, which is slightly higher than in the sample of this study.

Figure 1 shows the distribution of intelligence scores. By visual examination, it appears that there is a slight positive skew to the distribution. This could mean that there has already been a selection where there are fewer people with a low test score in the present sample than in the true population. There are only seven participants with a score of 1 and 17 with a score of 2, which probably does not leave enough statistical power to discover any trends related to the lowest intelligence scores, even if such trends exist in the population.

Figure 1: Distribution of intelligence scores in the sample

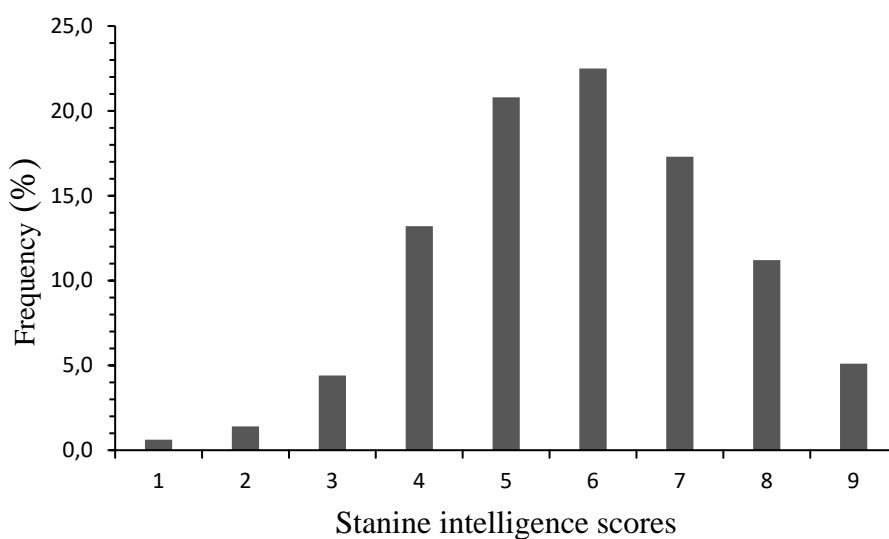


Table1: Descriptive statistics for all study variables (N = 1.118).

Variable	Mean/%	SD	Range
Childlessness	23.8%		
Intelligence	5.8	1.6	1-9
Highest form of completed education			
Junior high school	9.1%		
Senior high school	34.4%		
Bachelors degree	36.2%		
Masters degree	20.3%		
Civil Status (in 2017)			
Married	48.6%		
Cohabiting	28.3%		
Not married or cohabiting	23.2%		
Never been in a relationship	9%		
Number of years in a relationship 2005-2017	8.1	4.6	0-13
Number of years in a relationship before 2005	0.7	1.7	0-10.3
Income in 2005 (in 1000 NOK)	292	229	2-3402
Income in 2014 (in 1000 NOK)	694	663	0-11574

The average age of the participants when childlessness was measured was 40.15 years (SD = 1.96). The most common ages were 38 (n = 201), 39 (n = 399), 41 (n = 207) and 42 (n = 257).

3.2 Preliminary analyses

Table 2 shows descriptives of the parts of the sample who were childless in 2017 compared to those who were not. The childless group appears to be different from the participants with children on all aspects apart from education and intelligence. The fact that there is no difference in intelligence between the two groups indicates an absence of a linear effect of intelligence on childlessness.

In order to start performing inference statistics and examine whether any of the trends displayed above reach the level of significance, intercorrelations of the relevant variables were calculated using Pearson's r . The intercorrelations are displayed in table 3.

Table 2: Descriptive statistics of the population of childless men vs those who have had at least one child

Variables	Childless (N = 269)	Men with at least one child (N = 811)	Difference
	Means (SD)	Means (SD)	
Intelligence	5.9 (1.8)	5.8 (1.6)	0.1
Education			
Junior high school	11.3%	8.4%	-2.9%
Senior high school	36.6%	33.8%	-2.8%
Bachelor's degree	34.3%	36.7%	2.4%
Master's degree	17.7%	21.1%	3.4%
Civil Status			
Married	14.8%	59.0%	44.2%**
Cohabiting	20.3%	30.7%	10.4%**
Not married or cohabiting	64.8%	10.3%	-54.5%**
Number of years in a relationship 2005 – 2017	2.7 (3.7)	9.8 (3.3)	7.1**
Number of years in a relationship before 2005	0.4 (1.2)	0.9 (1.8)	0.5**
Never been in a relationship before 2005	25.3%	3.3%	-22%**
Income in 2005(in thousands)	243 (237)	307 (224)	64**
Income in 2014 (in thousands)	533 (316)	743 (729)	210**

Differences between means are examined with a t-test, while differences between percentages are examined by using Chi squares.

*. Difference significant at the 0.05 level (two-tailed)

** . Difference significant at the 0.01 level (two-tailed)

Table 3: Correlation table

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
1. Childlessness	-									
2. Intelligence test scores	.01	-								
3. Education	-.06	.38**	-							
4. Income 2005	-.12**	.02	-.12**	-						
5. Income 2014	-.14**	.09*	.14**	.32**	-					
6. Years cohabited or married 2005-2017	-.67**	.05	.10**	.19**	.13**	-				
7. Years in a relationship before '05	-.13**	.07*	.03	.05	.04	.15**	-			
8. Ever had a partner before 2005	-.34**	-.06	.00	.09**	.08*	.35**	.14**	-		
9. Alder	-.12**	.13**	.11**	.27**	.07*	.23**	.14**	.07*	-	
10. Age of entry into fatherhood	-	.13**	.22**	-.02	.00	-.33**	-.13**	-.15**	.01**	-

*. Correlation significant at the 0.05 level (two-tailed)

** . Correlation significant at the 0.01 level (two-tailed)

Age at the final point of measurement was significantly correlated with every other measure. Of these correlations, the correlation between intelligence and age is the odd one out. All of the other variables can be accrued over time, and thus a correlation with age is not particularly surprising. However, intelligence was measured when all the participants were at the same age, and thus age should not be correlated with intelligence. The most credible reason for this correlation is an artefact of the method of recruitment used in the Young in Norway study. The participants were all recruited at the same time, and from different educational institutions. The participants who were 38 and 39 at the final point of measurement, were recruited from junior high school, while the participants who were older were recruited from senior high school. Because junior high school is the highest level of mandatory schooling in Norway, a selection process had probably taken place, where the participants who had started senior high school on average were more intelligent than the average of their birth cohort. This selection process could explain the association between age and intelligence. Another potential explanation is a cohort-effect, where average intelligence was lower for the younger cohorts than the older. Sundet et al. (2004) found that the national average intelligence of the youngest cohorts in the present study was lower than the older cohorts, in their study of the conscription intelligence test scores of all men of a range of cohorts in Norway, It is possible that both recruitment and cohort-effects are responsible for this correlation between age and intelligence.

Regardless of why the correlation between intelligence and age exists, when age was also correlated with childlessness, it could act as a confounding variable. Age was therefore controlled for in all other analyses

Analyses of whether the participants have completed their reproductive careers

It is possible that not all of the participants had completed their reproductive careers when childlessness was measured. Age at first child was included in an attempt to estimate whether there could be any systematic differences in which of the participants who would go on to have children after childlessness was measured in the present study. Whether intelligence predicts later entry into fatherhood is of special interest, as this could spuriously create an association between higher levels of intelligence and childlessness which might disappear if childlessness had been measured at a later age

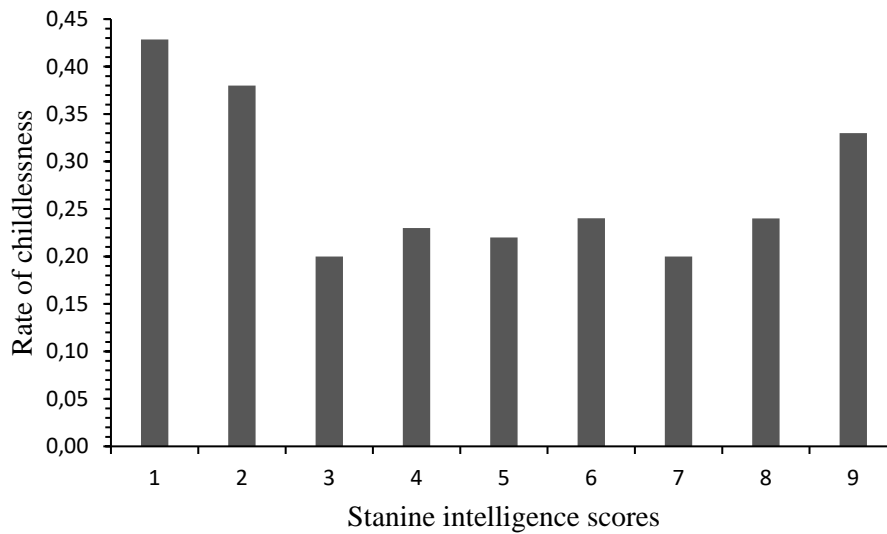
The correlation table above shows that age of entry into fatherhood is positively correlated with intelligence. In order to examine whether age of entry into fatherhood was associated with intelligence when age was controlled for, a linear regression analysis was performed with intelligence as the predictor, and age of entry into fatherhood as the outcome. Age was controlled for. The analysis was only performed on the participants who had children, as it does not make sense to assign an age of entry into fatherhood when you have not had children. Intelligence ($B = 0.33, p < 0.01$) significantly predicted age of entry into fatherhood. This means that the childless participants that go on to have children after childlessness was measured in the present study, might be more intelligent than those who had children earlier. The possibility that a positive association between intelligence and childlessness may be overestimated is important to the interpretation of the results of the main analyses.

3.3 Direct and indirect associations between intelligence and childlessness

Based on the results of the correlation analysis between intelligence and childlessness, as well as the t-test of the difference in average intelligence score between the participants with and without children, it is unlikely that a linear association exists between intelligence and childlessness. A logistic regression analysis was performed in order to confirm these findings. With age controlled for, intelligence was not significantly associated with any changes in risk of childlessness ($OR = 1.03, p = 0.48$). Given the absence of a linear effect, the association between intelligence and childlessness was graphed out in order to see whether any non-linear effects might exist.

In Figure 2, the prevalence of childlessness is displayed for each intelligence score. As the table shows, higher levels of childlessness seem to be associated with the scores of 1, 2 and 9. The other scores show some variation, but comparably lower levels of childlessness than these three scores. Based on visual examination of Figure 2, it is possible that a non-linear association between intelligence and childlessness exists.

Figure2: Distribution of childlessness by intelligence score



A logistic regression analysis that included an exponential intelligence term was performed in order to investigate the presence of a non-linear association. In this analysis, a significant negative association for the linear term ($OR = 0.638$, $p = 0.045$), and a significant positive association with the exponential term ($OR = 1.04$, $p = 0.038$) was found. However, none of these terms remained significant when age was controlled for. When including a quadratic term in the analysis, it is assumed that the same association exists for both extremes of the distribution of intelligence stanine scores. It is possible that the lack of statistical power in the lower level of intelligence scores contributed to the fact that a significant association was not found when age was controlled for.

In order to examine whether an association with childlessness exists for only certain stanine intelligence scores, a new logistic regression analysis was performed where intelligence was treated as a categorical variable. The middle stanine intelligence score of 5 was used as a reference variable, because it lies in the middle of the distribution visually and it is the average score in the norming population. Furthermore, both terminal scores of 1 and 9 have too few participants to reach satisfactory statistical power when used as a reference group. Age was controlled for as per the discussion surrounding the associations between age, childlessness and intelligence above. The results are displayed in table 4.

Table 4: Logistic regression analysis with intelligence treated as a categorical variable and childlessness as the outcome variable

95% C.I. for Odds Ratio				
Predictor	Odds Ratio	Lower	Upper	<i>p</i>
Intelligence (1)	2.43	0.52	11.30	0.26
Intelligence (2)	1.84	0.63	5.35	0.26
Intelligence (3)	0.82	0.38	1.77	0.61
Intelligence (4)	1.08	0.65	1.77	0.77
Ref: Intelligence (5)				
Intelligence (6)	1.16	0.75	1.78	0.51
Intelligence (7)	0.97	0.60	1.56	0.89
Intelligence (8)	1.14	0.68	1.93	0.62
Intelligence (9)	1.91	1.01	3.62	0.047
Alder	0.83	0.76	0.92	< 0.01

As can be seen in table 4, there was a statistically significant increase in risk of childlessness associated with having the highest intelligence score, relative to having a score of 5.. The risk of childlessness is approximately twice as high for the participants with a stanine intelligence score of 9 relative to the participants with a stanine intelligence score of 5. However, while this increase in risk is statistically significant, it is only marginally significant, and the confidence interval ranges from a 1% increase in risk of childlessness, to an almost fourfold increase. Furthermore, there is a high increased risk associated with stanine intelligence scores one and two, even if these trends are not statistically significant. It is possible that these associations would reach the level of significance if more participants with the lowest two scores were included.

Thus, a total effect of intelligence on childlessness has been established, even if it is just marginally significant. As discussed above, in order to establish whether a mediated association exists, it is first necessary to establish that the mediating variable is associated with the predictor and the outcome variable. Second, the association between the predictor and the outcome variable needs to be attenuated by the inclusion of the mediating variable in a statistical analysis. In order to examine whether this effect is mediated by any of the study variables it is first necessary to establish that an association exists between these variables and both intelligence and childlessness.

In order to determine whether the potential mediators are associated with childlessness logistic regression analyses were performed individually for each variable with childlessness as the outcome variable and with age controlled for. The results are presented in Table 5. Both measures of relationship history and income are statistically significant negatively associated with childlessness, while no statistically significant association exists between childlessness and education. The more recent measures appear to be more strongly associated with childlessness, with both income in 2014 being more strongly associated with childlessness than income in 2005, and years in a relationship after 2005 being more strongly associated with childlessness than years in a relationship before 2005.

Table 5: Logistic regression analysis of each study variable individually with childlessness as the outcome variable controlling for age

Predictor	95% C.I. for Odds Ratio		<i>p</i>	
	Odds Ratio	Lower		Upper
Ref: Education				
(junior high)				
Education	0.88	0.54	1.43	0.60
(senior high)				
Education	0.79	0.48	1.30	0.35
(bachelor)				
Education	0.69	0.41	1.19	0.19
(master)				
Income 2014	0.26	0.17	0.40	<0.01
Income 2005	0.69	0.55	0.87	<0.01
Years in a relationship before 2005	0.80	0.71	0.90	<0.01
Years in a relationship after 2005	0.64	0.61	0.67	<0.01
Ever had a partner before 2005	0.10	0.06	0.16	<0.01

In order to examine whether having a stanine intelligence score of 9 is associated with the study variables, regression analyses were performed with having a stanine intelligence score of 9 as the predictor variable and the study variables as outcome variables. Where the outcome variable is continuous, a linear regression was used, and where the outcome variable is dichotomous, logistic regression was used. Age was controlled for in all analyses. Having a

stanine intelligence score of 9 is statistically significant positively associated with income in 2014 ($B = 0.34, p = 0.02$), but not with income in 2005 ($B = .09, p = 0.49$). Furthermore, having a stanine intelligence score of 9 is not statistically significantly associated with years spent in a relationship before 2005 ($B = -0.12, p = 0.60$), or after 2005 ($B = -0.48, p = 0.44$). Intelligence is, however, significantly associated with whether participants had ever been in a relationship in 2005, and it is the only stanine intelligence score to display this association, as can be seen in table 6.

Table 6: Logistic regression analysis with intelligence as the predictor variable and ever having been in a relationship in 2005 as the outcome variable. Age was controlled for.

95% C.I. for Odds Ratio				
Predictor	Odds Ratio	Lower	Upper	<i>p</i>
Intelligence (1)	0.68	0.08	5.96	0.79
Intelligence (2)	0.51	0.14	1.97	0.33
Intelligence (3)	1.75	0.50	6.12	0.39
Intelligence (4)	2.02	0.84	4.90	0.12
Ref: Intelligence (5)				
Intelligence (6)	1.37	0.70	2.67	0.36
Intelligence (7)	1.16	0.57	2.36	0.68
Intelligence (8)	0.91	0.43	1.93	0.81
Intelligence (9)	0.36	0.16	0.79	0.01
Alder	1.20	0.76	0.92	< 0.01

Based on the above analyses, income in 2014 and whether participants have ever been in a relationship before 2005 are associated with both childlessness and intelligence, meaning they can potentially mediate the association between intelligence and childlessness. The final step in the process of examining whether these two variables mediate the association between

intelligence and childlessness is to include them in the logistic regression model with intelligence and examine whether the effect of intelligence is attenuated. If the effect changes, but is still present, the association is partially mediated, if the effect disappears altogether the association is fully mediated. The results can be seen in table 7.

Table 7: Logistic regression analysis of intelligence and potential mediating variables with childlessness as the outcome variable.

95% C.I. for Odds Ratio				
Predictor	Odds Ratio	Lower	Upper	<i>p</i>
Intelligence (1)	1.60	0.32	8.02	0.57
Intelligence (2)	1.23	0.28	4.00	0.73
Intelligence (3)	0.86	0.38	1.99	0.73
Intelligence (4)	1.20	0.70	2.08	0.51
Ref: Intelligence (5)				
Intelligence (6)	1.28	0.80	2.05	0.31
Intelligence (7)	1.04	0.61	1.78	0.89
Intelligence (8)	1.15	0.63	2.07	0.65
Intelligence (9)	1.72	0.79	3.73	0.18
Income in 2014	0.25	0.16	0.40	<0.01
Ever had a partner before 2005	0.11	0.07	0.19	<0.01
Alder	0.85	0.76	0.94	<0.01

As shown in Table 7, the effect of stanine intelligence score 9 relative to stanine intelligence score 5 does not remain above the level of significance when income in 2014 and whether participants have ever had a partner before 2005 was controlled for. Additional analyses with each potential mediator included separately show that with only income in 2014 included in the model, the effect of stanine intelligence score 9 is maintained and slightly increased (OR = 2.18, $p = 0.03$). When only whether participants have ever been in a relationship by 2005 was included, the effect of stanine intelligence score 9 is no longer significant (OR = 1.47, $p = 0.29$). It is a common conception that if an effect is no longer statistically significant when a mediator is controlled for it signifies total mediation. However, Baron and Kenny (1986) caution against using non-significance of the direct effect as evidence of complete mediation. Instead, they advise that an estimation of the ratio of the effect being mediated should be calculated. Ratios above 0.8 should be found in order to conclude with complete mediation. Still, they also warn that the estimate could be unstable in small effects and at a low n .

'Ever having had a partner by 2005' was estimated to mediate approximately half of the effect of stanine intelligence score 9 on childlessness. Income on the other hand, received a negative estimate of the proportion of the effect being mediated of approximately one third. This is because income is an inconsistent mediator of the effect of intelligence on childlessness, and the indirect effect through income is in the opposite direction of the total effect of intelligence on childlessness. The negative ratio may mean that the direct effect of stanine intelligence score of 9 on childlessness is increased by one third because of the effect mediated through income.

The Z-mediation test of significance recommended by Iacobucci (2012) found a Z-value of 2.45 for 'ever had a partner' and -2.13 for income. These z-values translate to a p-value of 0.01 and 0.03 respectively, meaning that both the indirect effect of income and 'ever had a partner' were above the level of significance.

Taken together this suggests that the effect of intelligence on childlessness is at least partially mediated by both income in 2014 as well as whether participants had been in a relationship by their late twenties. However, these two mediators appear to work in opposite directions. Income in 2014 is negatively associated with childlessness and positively associated with intelligence, and thus the indirect effect of intelligence on childlessness through income in 2014 is negative, making it an inconsistent mediator. On the other hand, whether participants have ever been in a relationship by 2005 is negatively associated with both childlessness and

intelligence, and thus mediates a positive association between intelligence and childlessness. No significant direct effect of intelligence on childlessness was found when 'ever having had a partner by 2005' was included in the regression model. However, as described above, it is not possible to conclude whether this association is completely or partially mediated by whether participants had ever been in a relationship by 2005.

4 Discussion

The aim of the study was to investigate the direct and indirect associations between intelligence measured in the participants early twenties and childlessness in the end of their thirties/beginning of their forties, in a sample of 1081 men. The present study did not find a linear association between intelligence and childlessness. However, further analysis revealed a total effect of increased risk of childlessness associated with an intelligence score two standard deviations or more above the normed average. Furthermore, I found an indirect effect of the highest stanine intelligence score on childlessness through both income and early relationship history but in opposite directions. While early relationship history mediated a positive effect of an intelligence score two standard deviations above the normed average or more on childlessness, an inconsistent mediated effect was found for income. A direct effect of the highest stanine intelligence score on childlessness did not reach significance when both income and whether the participants had ever been in a relationship by their late twenties was included. It is uncertain whether early relationship history completely mediated the effect of intelligence on childlessness, but it is clear that a significant indirect effect of intelligence on childlessness through both income and whether participants had ever been in a relationship by their late twenties was present. In the discussion, the total association between intelligence and childlessness will be discussed, followed by the direct and indirect effects of intelligence on childlessness, and how these can be interpreted. Finally, I will review possible theoretical implications of the findings.

4.1 The total association between intelligence and childlessness

Regarding the total association between intelligence and childlessness the present study has two main findings: the absence of a linear association between intelligence and childlessness, and an increase in risk of childlessness associated with the highest level of intelligence relative to the normed average.

As was reviewed in the introduction, the three studies that have investigated the association between intelligence and childlessness measured after 40 years of age all have different results. One found a positive association (von Stumm et al., 2011), the second found no association (Kanazawa, 2014), and the third found a negative association (Kolk & Barclay,

2019). There are several factors that might explain the differences between the findings of these studies and the present study.

Firstly, the analyses run differed. Both Kanazawa (2014) and (von Stumm et al., 2011) treated intelligence as a continuous variable in their analyses of the association between intelligence and childlessness. They found no association and a positive association respectively. Kolk and Barclay (2019) did not explicitly test non-linear associations, but because they included every Swedish male born in a 16 year period, differences in mean childlessness rates can still be interpreted without significance testing, which allows them to examine differences between intelligence ranges. Neither Kanazawa (2014) nor Von Stumm et al. (2011) had the ability to discover the same kinds of non-linear association that were found in the present study. Kolk and Barclay (2019) on the other hand did not find any notable differences among the higher intelligence scores, but rather an increased risk of childlessness associated with the lower intelligence scores. The present study found a non-significant trend towards the lowest intelligence scores increasing the risk of childlessness relative to the normed average. It is possible that the results of Kolk and Barclay (2019) would have been replicated in the present study if more participants with the lowest intelligence scores were included.

The present study examines a cohort that was born later than those included in other published studies on intelligence and either fertility or childlessness measured after 40 years of age considered here. von Stumm et al. (2011) studied cohorts born between 1950 and 1956, while Kanazawa (2014) used a sample that originally included every baby born in the span of a week in 1958. Kolk and Barclay (2019) studied some younger cohorts, including men born between 1951 and 1967. Finally, the present study includes participants born between 1973 and 1979. There is an overlap in age between the three previous studies, while the present study is based on a cohort that is 10-20 years younger.

It is possible that the effect of intelligence on childlessness is changing, and that such changes can explain some of the differences in results between the present study and other studies. For instance, a recent study from the US reported no linear association between intelligence and fertility for men above 44 born between 1951 and 1973 while the association between intelligence and fertility was present in older cohorts (Meisenberg, 2019). Even though Meisenberg (2019) studied fertility and not childlessness in a different demographic context from Norway, it may be that a similar trend in terms of the weakening of the association

between intelligence and fertility exists in Norway for the association between intelligence and childlessness.

Where the study was conducted may make a difference. von Stumm et al. (2011) and Kanazawa (2014) studied participants from Scotland and all of Great Britain respectively. Kolk and Barclay (2019) on the other hand studied men born in Sweden. The present study included participants born in Norway. It is possible that the demographic setting of these studies influenced the outcome. All these countries are fairly similar, so it is not a stretch to assume that findings from one could be generalized to the others. The four samples studied are all from European countries, with similar social structures and an individualistic culture. However, they could be divided into two pairs based on a presumed degree of similarity, the samples in Great Britain and those in Scandinavia. One could then expect that the results of the studies would reflect these pairings, but they don't, which is somewhat surprising.

Kanazawa (2014) and von Stumm et al. (2011) were both based on survey data, while Kolk and Barclay (2019) was based on register data. As discussed in the introduction, using survey data may fail to include the least intelligent participants and may even inflate a positive effect of intelligence on childlessness. This may be why Kanazawa (2014) and von Stumm et al. (2011) found a positive or no association, while Kolk and Barclay (2019) found a negative association. The present study has a sample recruited through a survey, but because the final follow-up was performed with register data, it may be less vulnerable to drop-out.

Methodologically, the present study falls between the studies who used survey-based data and those who used register based data. If the present study had been solely based on register data, it might have included more participants with the lowest intelligence scores. More participants with lower intelligence scores might have provided sufficient statistical power for the trend towards lower intelligence scores being associated with higher rates of childlessness reach significance. If a significant association between the lower levels of intelligence and childlessness had reached significance, the present study would have presented a more similar picture to the results of Kolk and Barclay (2019).

Taken together, the present study has greater similarity with Kolk and Barclay (2019) than with the other two previous studies. This holds for both age, and demographic setting. Furthermore, the measurement of intelligence is also similar as both studies rely on intelligence measured in the context of evaluation for mandatory military service. Given these similarities, it is somewhat surprising that the results of the two studies are in opposite

directions, with the present study finding a positive association between intelligence and childlessness, while the Swedish study reported a negative association. This may in part be explained by the largest differences between the two studies: the age at which childlessness was measured, the number of participants included and the mode of data collection. If more participants had been included, the effect of having the lowest two intelligence scores may have reached significance and the effect of the highest intelligence score may have been attenuated if the sample was older.

In order to evaluate whether the association between intelligence and childlessness is predominantly direct, indirect or a mix, I will now discuss the results from the mediation analysis.

4.2 The indirect effects of intelligence on childlessness.

The results of the present study indicate that the total association between the highest levels of intelligence and childlessness is at least partially mediated by income and having had a partner by one's late twenties. In addition, no significant direct effect was found when these factors were included in the analysis. The associations between intelligence and the mediators, as well as between the mediators and childlessness are discussed in order to interpret these results.

4.2.1 Partnership history

The association between intelligence and partnership history had not been the subject of much previous research, and thus no hypothesis had been formed. The positive extreme of intelligence appears to be negatively associated with whether participants had ever had a partner by their late twenties, but not with any other measures of early relationship history. Furthermore, the positive extreme of intelligence appears to be the only level of intelligence to be associated with ever having had a partner by their late twenties

As touched upon in the introduction, successfully entering into romantic relationships has been shown to be predicted by prosocial behavior (Stavrova & Ehlebracht, 2015), income (Asendorpf et al., 2011) and education (Fisman et al., 2006). Prosocial behavior (Meeks Gardner et al., 2007), income (Strenze, 2007) and education (Roth et al., 2015) have all been

associated with intelligence as well, and as such the present results that intelligence is associated with partnership formation is not unexpected. Furthermore, Meisenberg (2010) also found that intelligence is associated with partner formation.

More surprisingly, intelligence was negatively associated with ever having been in a relationship by one's late twenties. All of the research above should implicate the opposite effect. One possible explanation could be that the most intelligent participants to a larger extent pursue academic goals or focus on their careers, while delaying family formation. Such an interpretation is further strengthened by the absence of significant associations between the positive extreme of intelligence and relationship outcomes later in life. Furthermore, the participants who had never had a partner by their late twenties were estimated to be ten times more likely to remain childless than those who had had a partner, even when intelligence was included in the analysis. This result is not surprising, given that the link between relationship history and childlessness has been established before (Jalovaara & Fasang, 2017; Keizer et al., 2008; Raab & Struffolino, 2019).

The effect of intelligence on childlessness was at least partially mediated by whether participants had ever been in a relationship by their late twenties. There are several ways this mediated association can be understood. Firstly, it is possible that whether a person has had a partner by their late twenties reflects some sort of underlying relationship competence, and that lower levels of this relationship competence predisposes these participants for childlessness. Studies have shown that relationship competence early in life is predictive of later romantic partner formation (Rauer, Pettit, Lansford, Bates, & Dodge, 2013), and partner formation is protective against childlessness (Jalovaara & Fasang, 2017; Raab & Struffolino, 2019). Such an explanation seems unlikely, however, as whether the participants had a partner by their late twenties was not related to how many years they had spent cohabiting or married until time of measurement. Nor was intelligence associated with less time spent cohabiting or married in the participants' thirties. It could be that intelligence is associated with lower relationship competence, but that it also confers other benefits that mitigate or lessen this effect. For instance, intelligence was positively associated with both education and income, which each were positively correlated with years spent in a relationship between 2005 and 2017. There is little support for this theory, as a supplementary analysis of the effect of intelligence on later relationship history showed no negative association when education and income was controlled for.

Another possible mechanism for the mediating effect of ever having had a partner by the participants' late twenties is through delayed family formation. It is possible that the most intelligent participants have the same family formation pathway, but that it is delayed relative to the less intelligent participants. If this is the case, not having had a partner at their late twenties may be an expression of this delay in partner formation rather than an inability to secure a partner. If so, the mediating effect would disappear, along with the positive association between having an intelligence score two standard deviations above the normed average and childlessness, if childlessness was measured later. Some support exists for such an interpretation. For instance, intelligence is related to later first birth in previous studies (Heck et al., 1997; Neiss et al., 2002) and in the present study. In addition, education is associated with later entry into marriage (Perelli-Harris & Lyons-Amos, 2016), and intelligence is strongly correlated with education (Deary et al., 2007). These results together could indicate that intelligence leads to a later entry into fatherhood due to longer education and delayed partnership formation. The question that remains is whether the participants who have delayed partnership formation will “catch up” to the participants who created families earlier, and leave childlessness behind. The study by Kolk and Barclay (2019) may indicate that they do. They found that a positive association between higher intelligence and childlessness disappeared when childlessness was measured after 45/50 (Kolk & Barclay, 2019). Further studies are needed to investigate whether this mediated association is still present when childlessness is measured later than in the present study.

4.2.2 Socioeconomic factors

Education

No hypothesis was formed about the association between education and childlessness. In the present study, no significant association was found between education and childlessness, both when education was treated as a categorical and as a linear variable. Education was significantly associated with intelligence, which is in accordance with the hypothesis. However, as education was not significantly associated with childlessness it cannot act as a mediating factor.

Some studies have found an association between education and childlessness (Nisén, 2016; Trimarchi & Van Bavel, 2017), while others do not (Chudnovskaya, 2019; Kyzlinková &

Šťastná, 2018). Of the studies on the effect of intelligence on childlessness or fertility who have included a measure of education, most of them find no association between education and their measure of reproductive success (Chen et al., 2013; Kanazawa, 2014; Meisenberg, 2010, 2019). The two studies that found an effect of education on fertility found an effect only for single men (Meisenberg & Kaul, 2010) or when measuring fertility in the participants late twenties to early thirties (Michael A. Woodley of Menie et al., 2016). Thus, the present results that education was not associated with childlessness match the most common findings in the literature on intelligence and reproductive outcomes.

Income

In accordance with the hypotheses of the present study, income was negatively associated with childlessness. A reduced risk of childlessness associated with income replicates the findings of several studies investigating the association between income and childlessness or fertility (Barthold et al., 2012; Hopcroft, 2015; Keizer et al., 2008). Income was also found to be associated with reproductive outcomes in the literature on intelligence and fertility/childlessness in all of the studies that included it (Kanazawa, 2014; Meisenberg, 2010, 2019; Meisenberg & Kaul, 2010). The present findings seem to be in line with the rest of the literature on this point.

Furthermore, the indirect effect of intelligence on childlessness through income was negative, which is the opposite effect of the total effect. This means that the direct effect of intelligence on childlessness was greater than the total effect when income was included as a mediator. It makes sense that intelligence is associated with higher income, as an increased ability to problem solve and adapt flexibly to one's environment should increase vocational success. Indeed, intelligence has been found to predict vocational success (Hunter, 1986), and income (Strenze, 2007) in previous studies.

The association between income and childlessness has two potential pathways: one through access to romantic relationships, and another within already established romantic relationships. Evolutionary psychological theory predicts that women will choose men that have the greatest resources to invest in potential offspring, with research finding that women express a preference for cues related to higher income (Buss, 1989; Buss et al., 2001), and that income is a predictor of achieving romantic relationships for men (Asendorpf et al.,

2011). Thus, income could decrease the risk of childlessness through its effect on access to romantic partnerships, which is associated with a decreased risk of childlessness.

It is also possible that income leads to lower rates of childlessness even within partnerships. Higher income could increase the likelihood that partners make the decision to take on the cost associated with having a child. Some theorists have suggested that evolution may have predisposed us towards maximizing the amount of resources used per offspring, rather than maximizing the number of offspring (Luttbeg, Borgerhoff Mulder, & Mangel, 2000). Higher income may contribute to lower level of childlessness through exceeding the “threshold” of resources required for a family of two to invest in a new family member.

Both of these pathways seem reasonable, although the first is to a larger degree supported by previous research. Either way, a mediated association between intelligence and childlessness through income makes sense theoretically.

4.3 The direct effect of intelligence on childlessness

The present study did not find a direct association between intelligence and childlessness when partnership history and income was included in the analysis. This is in line with the findings of Kanazawa (2014). An absence of a direct effect between intelligence and fertility has also been found before, for instance in Meisenberg (2019). However, to the best of my knowledge the presence of a total effect and absence of a direct effect has not been demonstrated in the childlessness literature before among the studies that have measured childlessness after 40 years of age. Charlie L Reeve et al. (2013) found that the effect of intelligence on childlessness was mostly mediate by education, but they measured childlessness when participants were 29 years of age on average, and thus probably measured delayed childbearing. Considering that the present study did not find a linear effect of intelligence on childlessness, but found an effect associated with a single intelligence score, it is possible that previous studies would have found similar effects if similar analyses were performed. However, the present study appears to find support for indirect rather than direct effects of intelligence on childlessness.

4.4 Strengths and limitations

There are several strengths of the present study, the principal among them being the mix between survey and register based data. This mix of data collection method creates a compromise between the increased richness of data provided by survey methods, while benefiting from the reduced drop-out associated with register based data. This mix of data collection methods has also made it possible to use more dynamic relationship history measures than have been employed in any other study on the association between intelligence and reproductive outcomes to date. The schools the participants were recruited from were selected in a way that made sure the sample would be as representative as possible in comparison to the general population. In addition, the intelligence measure used

Furthermore, non-linear effects of intelligence on childlessness were examined, which has rarely been done before and never for the study of intelligence on childlessness. Through the application of non-linear statistical analyses the present study reveals a more complex association between intelligence and childlessness. In addition, the cohorts studied are the most recent cohorts studied to date, which makes the present results more relevant to the reality faced by cohorts that are presently in their procreating years. This is always a benefit, but the recent research indicating recent changes in the associations between intelligence and reproductive behavior Meisenberg, 2019 underlines this as a necessity. As culture is evolving ever faster, research needs to keep tracking these changing trends.

As many studies, the present study also has several weaknesses that are important to consider. First, the relatively recent cohorts is also one of the studies greatest weaknesses. The young age of the participants may have artificially inflated the effect of the highest intelligence scores. The supplementary analyses show a significant association between intelligence and age of entry into fatherhood. If several participants had not completed their reproductive careers in the present study, a positive association between higher intelligence and childlessness could be overestimated. Statistics from Statistics Norway show that childlessness rates decreased by 3.7% between the age of 40 and 50 for the most recent cohort where data is available (Statistics Norway, 2019). This decrease in childlessness rate is not large, but if the most intelligent are heavily overrepresented in these 3.7% it may be that any association between intelligence and childlessness could have disappeared if the participants in the present study were followed up when they reached their fifties.

Second, some of the participants were recruited from senior high school, while some were recruited from junior high school. Junior high school is part of mandatory schooling in Norway, while senior high school is not. This means that parts of my sample will already have been selected for higher intelligence, as is reflected in the results of the present study where the participants recruited from senior high school had higher intelligence scores on average. Furthermore, the older group has, on average, more education than the younger group, as well as higher wages, and have spent longer in cohabitation or marriage. In addition, the group that was recruited from junior high school has childlessness rates that are more representative of their cohort than those recruited further up in the educational system, which may indicate that the participants recruited from junior high school are more representative of the general population. As all participants were recruited at the same time, age is a good measure of this disparate recruitment, which also captures the fact that participants who have completed more years of senior high school were even less representative of the general population. Controlling for age thus compensated for some of these differences, but may not have controlled for all of them, and the level of education participants were recruited from may still be a confounding factor.

Third, the low number of participants at the lower levels of intelligence means that the study probably did not have enough power to detect any associations between the lowest levels of intelligence and childlessness. In the present sample, there are seven participants with a stanine intelligence score of one and 16 with a stanine intelligence score of two. Furthermore, there is a trend in the data towards increased risk of childlessness for the lowest two intelligence scores, even though it does not reach significance. If there were more participants with the two lowest scores in the sample, these trends might have reached significance. This could be related to the previously mentioned potential selection for higher intelligence, but could also be due to low intelligence increasing the likelihood of drop-out.

Fourth, the Young in Norway study is vulnerable to drop-out. The response rates of the four waves were 97%, 92%, 84%, and 82% respectively. This is not a very large drop-out, but as discussed above, drop-out is seldom random. The total drop-out was probably reduced by following up by register data rather than survey, but it may still have confounded the results of the present study.

Fifth, no distinction was made between voluntary and involuntary childlessness. No other study of intelligence and childlessness or fertility makes this distinction either. Theoretically,

the predictors for involuntary and voluntary childlessness might be different, and possibly diametrically opposite, which may mask effects that could become apparent when this distinction is made.

Sixth, the operationalization of the variables in the present paper might have influenced the results. For instance, no distinction was made between cohabiting or being married in years spent in a relationship between 2005 and 2017. Both attitudes about family and the quality of the relationship might affect both the decision to marry and the decision to have children, and this distinction could as such be relevant for childlessness. Furthermore, if occupational position was included in the measures of socioeconomic status, as opposed to only using income, more nuanced results might have been discovered.

Seventh, mediation analysis assumes causality. This means that intelligence should cause childlessness, as well as higher income and lower rates of having had a partner by the participants late twenties, and these mediators should in turn cause childlessness. Having employed a correlational design, it is not possible to assume causality. In terms of intelligence and childlessness, it does not make sense theoretically that childlessness should cause differences in intelligence. In addition, intelligence was measured when the participants were approximately 19 and thus the vast majority of them would not yet have children. Therefore, intelligence causing childlessness, if indirectly, can be inferred with a decent amount of certainty. However, this causality cannot be inferred for income or ever having had a partner by the late twenties. It is possible that the participants have already had children by the point that the mediators are measured, and thus childlessness could cause the changes in the mediators.

Eighth, while corrections for multiple comparisons were made within each individual analysis, corrections were not made between analyses. Because of the number of analyses that were performed, the probability of type 1 errors was inflated. All analyses that were performed were based on scientific results and theory, but it is possible that the total probability of false positives is above an alpha level of 0.05.

Ninth, some of the participants do not have a score on the intelligence test as part of evaluation for mandatory military service. It was not specified why these participants did not have a score, but for some reason they were taken in for evaluation but never tested..

Supplementary analyses showed that these participants have a statistically significant increase

in risk of childlessness, relative to the normed average, when controlling for age. Thus, it appears that some of the reasons for why these participants were excluded predisposes them for later childlessness. The exclusion of these participants from the analyses may be a weakness, as it appears that the reasons for exclusion from the tests are related to childlessness. On the other hand, it may be a strength, as participants may never be tested because they have some sort of observable developmental abnormality which may correlate with intelligence, and predispose them for childlessness. In other terms, the inclusion of these participants might have presented as a confounding factor.

Eleventh, no information about the spouses/partners of the participants were available in the present study. It is possible that relevant pathways of the association between intelligence and childlessness might be mediated through characteristics of the participants' partners.

4.5 Conclusion

The results of the present study did not support my hypothesis that intelligence should be negatively associated with childlessness. Moreover, I did not find a linear association between intelligence and childlessness. In a follow-up analysis I found that higher risk of childlessness was associated with having an intelligence score two standard deviations or more above the normed average. The total association between the highest bound of intelligence is primarily indirect through income and whether participants have ever been in a relationship by their late twenties. No direct effect of the highest bound of intelligence on childlessness was found when these two factors are included in the analysis. Income and whether participants had ever been in a relationship by their late twenties mediated opposite indirect effects of intelligence on childlessness. While the highest bound of intelligence reduces the risk of childlessness through higher income, it also increases the risk of childlessness through the participants with the highest level of intelligence to a lesser degree having had a partner by their late twenties.

The indirect association between intelligence and childlessness mediated by income is seen as an expression of higher intelligence granting the participants greater resources which both makes it easier to acquire partners, and to make the decision to have children within already established partnerships. The indirect association between intelligence and childlessness mediated by the participants ever having had a partner by their late twenties is seen as an expression of delayed partner formation, and previous research indicates that they may catch

up if childlessness is measured at a later point. In summary, the present study finds support for indirect rather than direct associations between intelligence and childlessness.

Future research should continue the focus on childlessness rather than fertility. Furthermore, future studies could benefit from employing a combination of survey-based and register-based data, as was the case in the present study. The present study illustrates how more nuanced relationship history measures than a simple civil status measure, or years married may reveal more nuanced and complex indirect associations between intelligence and childlessness.

Furthermore, analyses of non-linear associations between intelligence and childlessness could further contribute towards providing a more nuanced and accurate image of this association.

Future research should continue the focus on childlessness as a separate phenomenon within fertility research. At the same time, researchers should balance measuring completed fertility with recruiting cohorts that are as close in age as possible with the cohorts that are currently in the middle of their reproductive careers. Furthermore, samples should be recruited in such a way that as many participants as possible with lower intelligence levels are included in the analysis, in order to allow for enough statistical power to discover associations with the lower bounds of intelligence. This is especially important as intelligence is associated with less participation in research, as well as higher rates of dropout. In, addition, future research should attempt to distinguish between voluntary and involuntary childlessness, which may enable us to gain a greater understanding of the predictors of these two types of childlessness, which may have separate predictors. Finally, future research should continue the effort of discovering the pathways by which intelligence is associated with childlessness rather than simply examining whether intelligence is associated with childlessness at all. Especially the mediation of the association between intelligence and childlessness by psychological constructs rather than demographic factors would be of special interest.

References

- Anderson, R. T., Sorlie, P., Backlund, E., Johnson, N., & Kaplan, G. A. (1997). Mortality effects of community socioeconomic status. *Epidemiology*, 42-47.
- Antonucci, T. C., & Akiyama, H. (1987). An examination of sex differences in social support among older men and women. *Sex roles*, 17(11-12), 737-749.
- Asendorpf, J. B., Penke, L., & Back, M. D. (2011). From dating to mating and relating: Predictors of initial and long-term outcomes of speed-dating in a community sample. *European Journal of Personality*, 25(1), 16-30.
- Bajema, C. J. (1968). Relation of fertility to occupational status, IQ, educational attainment, and size of family of origin: A follow-up study of a male Kalamazoo public school population. *Eugenics Quarterly*, 15(3), 198-203.
- Baron, R. M., & Kenny, D. A. (1986). The moderator–mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology*, 51(6), 1173.
- Barthold, J. A., Myrskylä, M., & Jones, O. R. (2012). Childlessness drives the sex difference in the association between income and reproductive success of modern Europeans. *Evolution and Human Behavior*, 33(6), 628-638.
doi:10.1016/j.evolhumbehav.2012.03.003
- Buss, D. M. (1989). Sex differences in human mate preferences: Evolutionary hypotheses tested in 37 cultures. *Behavioral and brain sciences*, 12(1), 1-14.
- Buss, D. M., Shackelford, T. K., Kirkpatrick, L. A., & Larsen, R. J. (2001). A half century of mate preferences: The cultural evolution of values. *Journal of Marriage and Family*, 63(2), 491-503.
- Callan, M. J., Kim, H., & Matthews, W. J. (2015). Predicting self-rated mental and physical health: The contributions of subjective socioeconomic status and personal relative deprivation. *Frontiers in psychology*, 6, 1415.
- Calvin, C. M., Deary, I. J., Fenton, C., Roberts, B. A., Der, G., Leckenby, N., & Batty, G. D. (2010). Intelligence in youth and all-cause-mortality: systematic review with meta-analysis. *International journal of epidemiology*, 40(3), 626-644.
- Ceci, S. J., & Williams, W. M. (1997). Schooling, intelligence, and income. *American Psychologist*, 52(10), 1051.
- Chamorro-Premuzic, T., & Furnham, A. (2008). Personality, intelligence and approaches to learning as predictors of academic performance. *Personality and Individual Differences*, 44(7), 1596-1603.
- Chen, H.-Y., Chen, Y.-H., Liao, Y.-K., & Chen, H.-P. (2013). Relationship of fertility with intelligence and education in Taiwan: a brief report. *Journal of Biosocial Science*, 45(4), 567-571.
- Chudnovskaya, M. (2019). Trends in Childlessness Among Highly Educated Men in Sweden. *European Journal of Population*. doi:10.1007/s10680-018-9511-3
- Conrad, H. S., & Jones, H. E. (1932). A field study of the differential birth rate. *Journal of the American Statistical Association*, 27(178), 153-159.
- Crawford, J. R., Obonsawin, M., & Allan, K. M. (1998). PASAT and components of WAIS-R performance: Convergent and discriminant validity. *Neuropsychological Rehabilitation*, 8(3), 255-272.
- Cubbin, C., LeClere, F. B., & Smith, G. S. (2000). Socioeconomic status and injury mortality: individual and neighbourhood determinants. *Journal of Epidemiology & Community Health*, 54(7), 517-524.

- de Wolff, P., & Van Slijpe, A. (1973). The relation between income, intelligence, education and social background. *European Economic Review*, 4(3), 235-264.
- Deary, I. J., Strand, S., Smith, P., & Fernandes, C. (2007). Intelligence and educational achievement. *Intelligence*, 35(1), 13-21.
- Dykstra, P. A., & Hagestad, G. O. (2007). Roads less taken: Developing a nuanced view of older adults without children. *Journal of family issues*, 28(10), 1275-1310.
- Fieder, M., & Huber, S. (2007). The effects of sex and childlessness on the association between status and reproductive output in modern society. *Evolution and Human Behavior*, 28(6), 392-398. doi:10.1016/j.evolhumbehav.2007.05.004
- Fisman, R., Iyengar, S. S., Kamenica, E., & Simonson, I. (2006). Gender differences in mate selection: Evidence from a speed dating experiment. *The Quarterly Journal of Economics*, 121(2), 673-697.
- Fitzpatrick, T., Rosella, L. C., Calzavara, A., Petch, J., Pinto, A. D., Manson, H., . . . Wodchis, W. P. (2015). Looking beyond income and education: socioeconomic status gradients among future high-cost users of health care. *American journal of preventive medicine*, 49(2), 161-171.
- Garrison, S. M., & Rodgers, J. L. (2017). Decomposing the causes of the socioeconomic status–health gradient with biometrical modeling. *Multivariate Behavioral Research*.
- Gignac, G. E., Darbyshire, J., & Ooi, M. J. I. (2018). Some people are attracted sexually to intelligence: A psychometric evaluation of sapiosexuality. 66, 98-111.
- González, M. G., Swanson, D. P., Lynch, M., & Williams, G. C. (2016). Testing satisfaction of basic psychological needs as a mediator of the relationship between socioeconomic status and physical and mental health. *Journal of health psychology*, 21(6), 972-982.
- Gottfredson, L. S. (1997). Mainstream science on intelligence: An editorial with 52 signatories, history, and bibliography. *Intelligence*, 24, 13-23. doi:10.1016/s0160-2896(97)90011-8
- Gottfredson, L. S., & Deary, I. J. (2004). Intelligence predicts health and longevity, but why? *Current Directions in Psychological Science*, 13(1), 1-4.
- Hayes, A. F. (2017). *Introduction to mediation, moderation, and conditional process analysis: A regression-based approach* (Second ed.). New York: Guilford Publications.
- Heck, K. E., Schoendorf, K. C., Ventura, S. J., & Kiely, J. L. (1997). Delayed childbearing by education level in the United States, 1969–1994. *Maternal and child health journal*, 1(2), 81-88.
- Higgins, J., Reed, E. W., & Reed, S. C. (1962). Intelligence and family size: A paradox resolved. *Eugenics Quarterly*, 9(2), 84-90.
- Hopcroft, R. L. (2015). Sex differences in the relationship between status and number of offspring in the contemporary US. *Evolution and Human Behavior*, 36(2), 146-151.
- Hunter, J. E. (1986). Cognitive ability, cognitive aptitudes, job knowledge, and job performance. *Journal of vocational behavior*, 29(3), 340-362.
- Iacobucci, D. (2012). Mediation analysis and categorical variables: The final frontier. *Journal of Consumer Psychology*, 22(4), 582-594.
- Jalovaara, M., & Fasang, A. (2017). From never partnered to serial cohabitators: Union trajectories to childlessness. *Demographic Research*, 36(55), 1703-1720. Retrieved from <https://www.demographic-research.org/volumes/vol36/55/>
- Jalovaara, M., Neyer, G., Andersson, G., Dahlberg, J., Dommermuth, L., Fallesen, P., & Lappégard, T. (2018). Education, Gender, and Cohort Fertility in the Nordic Countries. *European Journal of Population*. doi:10.1007/s10680-018-9492-2
- Jencks, C. (1979). Who Gets Ahead? The Determinants of Economic Success in America.
- Jensen, A.-M., & Østby, L. (2014). Stadig flere menn i Norge er barnløse. *Samfunnsspeilet*, 2.

- Kanazawa, S. J. S. s. r. (2014). Intelligence and childlessness. *48*, 157-170.
- Keeble, C., Baxter, P., Barber, S., & Law, G. (2015). Participation Rates In Epidemiology Studies And Surveys: A ReViewy 2007–2015. *The Internet Journal of Epidemiology*, *14*(1).
- Keizer, R., Dykstra, P. A., & Jansen, M. D. (2008). Pathways into childlessness: evidence of gendered life course dynamics. *J Biosoc Sci*, *40*(6), 863-878. doi:10.1017/S0021932007002660
- Keizer, R., Dykstra, P. A., & Poortman, A. R. (2009). Life Outcomes of Childless Men and Fathers. *European Sociological Review*, *26*(1), 1-15. doi:10.1093/esr/jcn080
- Kennedy, S., & Bumpass, L. (2008). Cohabitation and children's living arrangements: New estimates from the United States. *Demographic Research*, *19*, 1663.
- Kidd, S. A., Eskenazi, B., & Wyrobek, A. J. (2001). Effects of male age on semen quality and fertility: a review of the literature. *Fertility and sterility*, *75*(2), 237-248.
- Kolk, M., & Barclay, K. (2019). Cognitive ability and fertility among Swedish men born 1951-1967: evidence from military conscription registers. *Proc Biol Sci*, *286*(1902), 20190359. doi:10.1098/rspb.2019.0359
- Kyzlinková, R., & Šťastná, A. (2018). Fatherhood in a Changing Society: Shifts in Male Fertility Patterns. *Sociological Research Online*, *23*(2), 328-353. doi:10.1177/1360780418754565
- Lago, S., Cantarero, D., Rivera, B., Pascual, M., Blázquez-Fernández, C., Casal, B., & Reyes, F. (2018). Socioeconomic status, health inequalities and non-communicable diseases: a systematic review. *Journal of Public Health*, *26*(1), 1-14.
- Laplante, B., Castro-Martín, T., Cortina, C., & Fostik, A. L. (2016). The contributions of childbearing within marriage and within consensual union to fertility in Latin America, 1980-2010. *Demographic Research*, *34*, 827-844.
- Lappegård, T., & Rønsen, M. J. D. (2013). Socioeconomic Differences in Multipartner Fertility Among Norwegian Men. *50*(3), 1135-1153. doi:10.1007/s13524-012-0165-1
- Laurent, J., Swerdlik, M., & Ryburn, M. (1992). Review of validity research on the Stanford-Binet Intelligence Scale. *Psychological assessment*, *4*(1), 102.
- Lesthaeghe, R. (2010). The unfolding story of the second demographic transition. *Population and development review*, *36*(2), 211-251.
- Loeber, R., Menting, B., Lynam, D. R., Moffitt, T. E., Stouthamer-Loeber, M., Stallings, R., . . . Pardini, D. (2012). Findings from the Pittsburgh Youth Study: Cognitive impulsivity and intelligence as predictors of the age–crime curve. *Journal of the American Academy of Child & Adolescent Psychiatry*, *51*(11), 1136-1149.
- Luttbeg, B., Borgerhoff Mulder, M., & Mangel, M. (2000). To marry again or not: a dynamic model for demographic transition. *Adaptation and human behavior: an anthropological perspective*, 345-368.
- Lynn, R., & Van Court, M. (2004). New evidence of dysgenic fertility for intelligence in the United States. *Intelligence*, *32*(2), 193-201.
- MacKinnon, D. P., & Dwyer, J. H. (1993). Estimating mediated effects in prevention studies. *Evaluation review*, *17*(2), 144-158.
- MacKinnon, D. P., Krull, J. L., & Lockwood, C. M. (2000). Equivalence of the mediation, confounding and suppression effect. *Prevention science*, *1*(4), 173-181.
- Margana, L., Bhogal, M. S., Bartlett, J. E., & Farrelly, D. (2019). The roles of altruism, heroism, and physical attractiveness in female mate choice. *Personality and Individual Differences*, *137*, 126-130.
- Meeks Gardner, J. M., Powell, C. A., & Grantham-McGregor, S. M. (2007). Determinants of aggressive and prosocial behaviour among Jamaican schoolboys. *West Indian Medical Journal*, *56*(1), 34-41.

- Meisenberg, G. (2010). The reproduction of intelligence. *Intelligence*, 38(2), 220-230.
- Meisenberg, G. (2019). Social and Reproductive Success in the United States: The Roles of Income, Education and Cognition. *Mankind Quarterly*, 59(3).
- Meisenberg, G., & Kaul, A. J. M. Q. (2010). Effects of sex, race, ethnicity and marital status on the relationship between intelligence and fertility. *50(3)*, 151.
- Meisenberg, G., Lawless, E., Lambert, E., & Newton, A. (2006). The social ecology of intelligence on a Caribbean island. *Mankind Quarterly*, 46(4), 395.
- Miettinen, A., Rotkirch, A., Szalma, I., Donno, A., & Tanturri, M.-L. (2015). Increasing childlessness in Europe: Time trends and country differences. *Families and Societies. Working Paper Series*, 3.
- Neiss, M., Rowe, D. C., & Rodgers, J. L. (2002). Does Education Mediate the Relationship Between IQ and Age of First Birth? A Behavioural Genetic Analysis. *Journal of Biosocial Science*, 34(2), 259-275. doi:10.1017/S0021932002002596
- Nisén, J. (2016). Education and fertility: A study on patterns and mechanisms among men and women in Finland. *Publications of the faculty of social sciences*.
- Nisén, J., Martikainen, P., Myrskylä, M., & Silventoinen, K. J. E. J. o. P. (2018). Education, Other Socioeconomic Characteristics Across the Life Course, and Fertility Among Finnish Men. *34(3)*, 337-366. doi:10.1007/s10680-017-9430-8
- NRK. (2019, First of January). -Lag flere barn, ber statsministeren i sin nyttårstale. Retrieved from <https://www.nrk.no/norge/statsministeren-bekymret-over-lave-fodselstall-1.14362212>
- of Menie, M. A. W., Reeve, C. L., Kanazawa, S., Meisenberg, G., Fernandes, H. B., & de Baca, T. C. (2016). Contemporary phenotypic selection on intelligence is (mostly) directional: An analysis of three, population representative samples. *Intelligence*, 59, 109-114.
- Parker, K. C., Hanson, R. K., & Hunsley, J. (1992). MMPI, Rorschach, and WAIS: A meta-analytic comparison of reliability, stability, and validity.
- Perelli-Harris, B., & Lyons-Amos, M. (2016). Partnership patterns in the United States and across Europe: The role of education and country context. *Social Forces*, 95(1), 251-282.
- Purdie, D. M., Dunne, M. P., Boyle, F. M., Cook, M. D., & Najman, J. M. (2002). Health and demographic characteristics of respondents in an Australian national sexuality survey: comparison with population norms. *Journal of Epidemiology & Community Health*, 56(10), 748-753.
- Raab, M., & Struffolino, E. (2019). The Heterogeneity of Partnership Trajectories to Childlessness in Germany. *European Journal of Population*. doi:10.1007/s10680-019-09519-y
- Rauer, A. J., Pettit, G. S., Lansford, J. E., Bates, J. E., & Dodge, K. A. (2013). Romantic relationship patterns in young adulthood and their developmental antecedents. *Developmental psychology*, 49(11), 2159.
- Reeve, C. L., Heeney, M. D., & Woodley of Menie, M. A. (2018). A systematic review of the state of literature relating parental general cognitive ability and number of offspring. *Personality and Individual Differences*, 134, 107-118. doi:<https://doi.org/10.1016/j.paid.2018.05.036>
- Reeve, C. L., Lyerly, J. E., & Peach, H. (2013). Adolescent intelligence and socio-economic wealth independently predict adult marital and reproductive behavior. *Intelligence*, 41(5), 358-365.
- Roth, B., Becker, N., Romeyke, S., Schäfer, S., Domnick, F., & Spinath, F. M. (2015). Intelligence and school grades: A meta-analysis. *Intelligence*, 53, 118-137.

- Rushton, J. P. (1985). Differential K theory: The sociobiology of individual and group differences. *Personality and Individual Differences*, 6(4), 441-452.
- Scheier, M. F., & Carver, C. S. (1992). Effects of Optimism on Psychological and Physical Well-Being - Theoretical Overview and Empirical Update. *Cognitive Therapy and Research*, 16(2), 201-228. doi:Doi 10.1007/Bf01173489
- Sewell, W. H., & Shah, V. P. (1967). Socioeconomic status, intelligence, and the attainment of higher education. *Sociology of education*, 1-23.
- Skrede, K. (2004). Færre menn blir fedre. *Økonomiske analyser*, 6.
- Snyderman, M., & Rothman, S. (1987). Survey of expert opinion on intelligence and aptitude testing. *American Psychologist*, 42(2), 137.
- Stafford, M., Black, S., Shah, I., Hardy, R., Pierce, M., Richards, M., . . . Kuh, D. (2013). Using a birth cohort to study ageing: representativeness and response rates in the National Survey of Health and Development. *European journal of ageing*, 10(2), 145-157.
- Statistics Norway. (2019, 7th of March). Fødte. Retrieved from www.SSB.no/fodte
- Stavrova, O., & Ehlebracht, D. (2015). A longitudinal analysis of romantic relationship formation: The effect of prosocial behavior. *Social Psychological and Personality Science*, 6(5), 521-527.
- Sternberg, R. J. (2000). *Handbook of intelligence*: Cambridge University Press.
- Strenze, T. (2007). Intelligence and socioeconomic success: A meta-analytic review of longitudinal research. *Intelligence*, 35(5), 401-426.
- Stringhini, S., Carmeli, C., Jokela, M., Avendaño, M., Muennig, P., Guida, F., . . . Bochud, M. (2017). Socioeconomic status and the 25× 25 risk factors as determinants of premature mortality: a multicohort study and meta-analysis of 1· 7 million men and women. *The Lancet*, 389(10075), 1229-1237.
- Sundet, J. M., Barlaug, D. G., & Torjussen, T. M. (2004). The end of the Flynn effect?: A study of secular trends in mean intelligence test scores of Norwegian conscripts during half a century. *Intelligence*, 32(4), 349-362.
- Sundet, J. M., Tambs, K., Magnus, P., & Berg, K. (1988). On the question of secular trends in the heritability of intelligence test scores: A study of Norwegian twins. *Intelligence*, 12(1), 47-59.
- Trimarchi, A., & Van Bavel, J. J. D. (2017). Education and the Transition to Fatherhood: The Role of Selection Into Union. 54(1), 119-144. doi:10.1007/s13524-016-0533-3
- Vining Jr, D. R. (1982). On the possibility of the reemergence of a dysgenic trend with respect to intelligence in American fertility differentials. *Intelligence*, 6(3), 241-264.
- Vining Jr, D. R. (1995). On the possibility of the reemergence of a dysgenic trend with respect to intelligence in American fertility differentials: an update. *Personality and Individual Differences*, 19(2), 259-263.
- Voigt, L. F., Koepsell, T. D., & Daling, J. R. (2003). Characteristics of telephone survey respondents according to willingness to participate. *American Journal of Epidemiology*, 157(1), 66-73.
- von Soest, T., Wichstrøm, L., & Kvaem, I. L. (2016). The development of global and domain-specific self-esteem from age 13 to 31. *Journal of Personality and Social Psychology*, 110(4), 592-608. doi:10.1037/pspp0000060
- von Stumm, S., Batty, G. D., & Deary, I. J. (2011). Marital status and reproduction: Associations with childhood intelligence and adult social class in the Aberdeen children of the 1950s study. *Intelligence*, 39(2), 161-167. doi:<https://doi.org/10.1016/j.intell.2011.02.007>
- Wang, M., Fuerst, J., & Ren, J. (2016). Evidence of dysgenic fertility in China. *Intelligence*, 57, 15-24.

- Weitof, G. R., Burström, B., & Rosén, M. (2004). Premature mortality among lone fathers and childless men. *59*(7), 1449-1459.
- Wiik, K. A., & Dommermuth, L. (2014). Who Remains Unpartnered by Mid-Life in Norway? Differentials by Gender and Education. *Journal of Comparative Family Studies*, *45*(3), 405-424. Retrieved from <http://www.jstor.org/stable/24339545>
- Williams, D. R., Priest, N., & Anderson, N. B. (2016). Understanding associations among race, socioeconomic status, and health: Patterns and prospects. *Health Psychology*, *35*(4), 407.
- Willoughby, R. (1928). Fertility and Parental Intelligence. *American Journal of Psychology*, *40*, 671.
- Willoughby, R. R., & Coogan, M. (1940). The correlation between intelligence and fertility. *Human Biology*, *12*(1), 114.
- Wilson, E. O. (2000). *Sociobiology* (H. Schaepfer Ed.): Harvard University Press.
- Woodley, M. A. (2011). The cognitive differentiation-integration effort hypothesis: A synthesis between the fitness indicator and life history models of human intelligence. *Review of General Psychology*, *15*(3), 228-245.
- Woodley of Menie, M. A., Cabeza de Baca, T., Fernandes, H. B. F., Madison, G., Figueredo, A.-J., & Peñaherrera Aguirre, M. (2017). Slow and Steady Wins the Race: K Positively Predicts Fertility in the USA and Sweden. *Evolutionary Psychological Science*, *3*(2), 109-117. doi:10.1007/s40806-016-0077-1
- Woodley of Menie, M. A., Figueredo, A. J., Dunkel, C. S., & Madison, G. (2015). Estimating the strength of genetic selection against heritable g in a sample of 3520 Americans, sourced from MIDUS II. *Personality and Individual Differences*, *86*, 266-270.
- Woodley of Menie, M. A., Schwartz, J. A., & Beaver, K. M. (2016). How Cognitive Genetic Factors Influence Fertility Outcomes: A Mediation SEM Analysis. *Twin Research and Human Genetics*, *19*(6), 628-637. doi:10.1017/thg.2016.82
- Young, A. F., Powers, J. R., & Bell, S. L. (2006). Attrition in longitudinal studies: who do you lose? *Australian and New Zealand journal of public health*, *30*(4), 353-361.