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Fernanda Cunha Soares, Göran Dahllöf, Anders Hjern & Annika Julihn

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ORIGINAL ARTICLE

U-shaped association between maternal age at delivery and dental caries in offspring

Fernanda Cunha Soares[a], Göran Dahllöf[a,b,c], Anders Hjern[d] and Annika Julihn[a,b,e]

[a]Department of Dental Medicine, Division of Orthodontics and Pediatric Dentistry, Karolinska Institutet, Stockholm, Sweden; [b]Center for Pediatric Oral Health Research, Stockholm, Sweden; [c]Center for Oral Health Services and Research, Mid-Norway, TkMidt, Trondheim, Norway; [d]Department of Medicine, Clinical Epidemiology, Karolinska Institutet and Centre for Health Equity Studies (CHESS), Stockholm, Sweden; [e]Department of Pediatric Dentistry, Eastman Institute, Stockholm, Sweden

ABSTRACT

Objective: To determine the association between maternal age at delivery and caries in offspring.

Materials and methods: This registry-based cohort study included all children born between 2000 and 2003 and who were residing in Stockholm County, Sweden, at 7 years of age. Between 2007 and 2010, the cohort ($n = 65{,}259$) was examined to determine caries experience (deft scores) at 7 years of age. Age of mother at childbirth was retrieved from the patient histories. Data were analysed using linear regressions.

Results: The lowest mean deft occurred in children born to mothers aged 25–34 years. The final model – adjusted for sex, income, educational level, migration background, family situation, smoking, obesity, small for gestational age, and number of siblings – found that young mothers and older mothers were significant risk indicators for caries experience at 7 years of age.

Conclusions: The present study found a U-shaped relationship between maternal age at childbirth and caries experience in the offspring at age 7 years. The offspring of mothers under 25 or over 34 years of age are at greater risk of having more teeth with caries experience.

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Caries prediction; child; epidemiology; maternal age; risk assessment; socioeconomic factors

Introduction

A major demographic change affecting many aspects of child health is the increasing age of mothers at childbirth. In Sweden, median maternal age at first childbirth increased from 23.8 years in 1973 to 29.4 in 2018 [1]. More current statistics show that the birth rate among women over 40 years rose from 2% in 1968 to 5% in 2018, while the teen birth rate declined from 8% in 1968 to less than 1% in 2018 [2].

Advanced as well as young age at childbirth is associated with an increased risk of adverse birth outcomes such as low birth weight, preterm birth, intrauterine growth restriction and infant mortality [3,4]. Several studies have reported an association between maternal age, adverse birth outcomes, and a range of negative child health outcomes [5,6]. The mechanisms through which these varied effects of maternal age are mediated is unclear. Most likely, the underlying factors responsible for adverse birth outcomes – social factors, health and health behaviours – differ in younger and older mothers.

Dental caries is one of the most prevalent diseases globally [7]. Although caries prevalence in children has decreased in most high-income countries, prevalence is still high in disadvantaged groups where almost 30% of the 3-year-olds have caries experience [8]. In pre-school children, the aetiology of caries is complex and can be explained by conceptual models that include socio-economic, behavioural and biological factors [9,10].

Maternal age at childbirth has also been associated with dental caries in the offspring. Reports in the literature cite a higher risk of caries in children of young mothers [11,12]. One study from Singapore found that children born to mothers older than 34 years had higher caries rates compared to those born to mothers below 34 years of age [13], and Julihn et al. [14] found that children to both younger and older mothers had a higher caries experience at 7 years of age. Further, several studies have shown that later-born siblings in families with many children have a higher caries risk [15,16].

The present registry-based cohort study explored whether children of younger and older mothers have a higher caries risk compared to children born to mothers between 25 and 34 years of age at childbirth. A comparison of the risk indicators for caries experience at age 7 years in the children of younger mothers with the children of older mothers was also made.

Materials and methods

Study population

The present study is a retrospective registry-based cohort study. Data were obtained from the Public Health Care

CONTACT Fernanda Cunha Soares fernanda.cunha.soares@ki.se Department of Dental Medicine, Division of Orthodontics and Pediatric Dentistry, Karolinska Institutet, Alfred Nobels Allé 8, Stockholm 141 04, Sweden

Administration in Stockholm, national registries at the National Board of Health and Welfare, and Statistics Sweden (SCB). The Swedish personal identity number (PIN) [17] was used to extract patient data on dental caries and socioeconomic variables from various registries. Linkage was possible for all children with caries data and a PIN. A previous study presented the complete methodology [18], hence we only describe variables of interest for the present study here.

Children born in 2000–2003 and who were residing in Stockholm County, Sweden, at 7 years of age were eligible for inclusion. During 2007–2010, the cohort ($n = 65,259$: 33,423 boys; 31,836 girls) was examined at age 7 years by the Public Dental Service; private practitioners; or the Division of Pediatric Dentistry, Department of Dental Medicine, Karolinska Institutet. The Regional Ethics Board in Stockholm and the Swedish Data Inspection Board, a national agency that serves as an institutional review board for studies using database linkage, approved the protocol for this study (Daybook no. 2010/1563-31/1).

Variables

Data on caries experience (deft scores) were obtained from both clinical and radiographic examinations. We used the following caries indices: dt = decayed teeth, et = extracted teeth and ft = filled teeth. We also defined decayed teeth as caries on smooth surfaces at the lowest level that can be verified as a cavity and detectable by probing or, in fissures, by a catch of the probe under slight pressure. Proximal caries was defined as a lesion clearly extending into the dentine on bite-wing radiographs [19]. Some of the children had not been radiographically examined at a particular age because it was not indicated. We used the decayed, extracted and filled primary teeth (deft index) to measure the severity of the caries experience (deft scores) of the children at age 7. Only primary teeth were included in the data for the present study.

We collected the following variables from the Swedish Medical Birth Registry (MBR): maternal age (<25 years [young age at childbirth]; 25–34 years; >34 years [advanced age at childbirth]) [20,21], family situation (cohabiting, single mothers), maternal smoking habits during early pregnancy (no, yes), and maternal height and weight at the first visit to the public maternity healthcare clinic. The body mass index (BMI) of the mother was calculated and classified as BMI $<$ 30 or BMI $\geq$ 30. The adverse birth outcomes variables – preterm birth and small-for-gestational age (SGA) – were classified as no or yes.

From the Total Population Registry, we retrieved data on the mother's number of children and immigration background. The variables were analysed in the statistical analyses as '1, 2 or ≥3 children' and 'foreign-born mother: no or yes'.

From the Swedish National Tax Board, we collected information regarding the family's disposable income from the 2003 survey. The variable 'family income' was initially divided into quintiles. These subgroups were subsequently merged into two subgroups: ≤20% (lower income group) and >20% (higher income group), with highest income level as reference. The variable included all reported sources of income from which taxes were deducted. This sum was then divided by consumer units in the household.

We obtained data on maternal education level from the Register of Education. In the statistical analysis, we classified the variable 'maternal education level' according to the number of years of schooling that the mother had in 2003 as follows: ≤9 years and >9 years.

In our study cohort, these variables had missing values: maternal educational level, 347; smoking in early pregnancy, 6888; maternal obesity in early pregnancy, 12,519; preterm birth, 112; SGA, 2455; and number of children in the family, 9466. The variables maternal age, sex, family income, foreign-born mothers, family situation, and caries experience had no missing values.

Statistical analysis

We used the STATA version 14.0 (StataCorp LP, College Station, TX) to manage and statistically analyse our data. Data analysis used frequency tables to describe the data and assessed differences between means using a t-test.

We used linear regressions to analyse risk indicators of caries experience (deft scores) in 7-year-old children. In the linear regression analysis, nine models were tested. The risk indicators that remained significant in the multivariate analysis were the risk indicators that simultaneously best explained the dependent variable. We considered β with a 95% confidence interval (CI) and all p values<.05 to be significant.

Results

The mean deft score was 0.62 (±1.48) for children of mothers aged 25–34 years, 1.25 (±2.03) for children of mothers under 25 years of age, and 0.69 (±1.58) for children of mothers over 34 years of age.

Table 1 presents characteristics of the study population in relation to maternal age at delivery. In the group of mothers younger than 25 years at delivery, 35% had three children or more, while among mothers 35 years or older, 40% had three children or more ($p<.001$). Of mothers younger than 25 years, 44% were members of the group with the lowest family income compared to 13% of the oldest mothers ($p<.001$). Caries experience at 7 years was diagnosed in 22% of children born to mothers aged 25–34, 40% in mothers younger than 25, and 24% in mothers 35 or older.

Figure 1 shows a U-shaped correlation between mean deft at age 7 years and maternal age at childbirth. The lowest mean deft was found in children born to mothers aged 25–34 years.

Table 2 presents a linear regression analysis of risk indicators associated with caries experience (deft scores) at age 7 years. Our analysis of the data in nine steps adjusted for significant risk indicators in the crude analysis. In the crude analysis, all risk indicators were significantly associated with outcome. In the final model, we adjusted for sex, family

Table 1. Characteristics of the study population by maternal age at delivery.

		Maternal age at delivery						
		25–34 years		<25 years		>34 years		
Variables	Category	*n*	%	*n*	%	*n*	%	*p* Value
Sex	Boy	22,154	**51**	3336	**51**	7934	**51**	.601
	Girl	20,984	49	3225	49	7626	49	
Family income	>20%	35,485	82	3698	56	13,545	87	**<.001**
	≤20%	7653	18	2863	44	2015	13	
Maternal educational level, years	>9	39,992	93	4888	75	14,439	93	**<.001**
	≤9	2934	7	1641	25	1018	7	
Foreign-born mother	No	33,857	78	4071	62	12,182	78	**<.001**
	Yes	9281	21	2490	38	3378	22	
Maternal smoking in early pregnancy	No	36,143	94	4978	83	12,790	93	**<.001**
	Yes	2500	6	1014	17	946	7	
Maternal obesity in early pregnancy	No	32,681	93	5003	93	11,267	92	**.001**
	Yes	2419	7	402	7	968	8	
Family situation	Cohabiting	35,743	83	4627	70	12,546	81	**<.001**
	Single mothers	7395	17	1934	29	3014	19	
Preterm birth	No	40,713	95	6191	95	14,631	94	.385
	Yes	2361	5	356	5	895	6	
SGA	No	40,772	98	6234	97	14,471	98	**.001**
	Yes	837	2	175	3	315	2	
Number of children in family	1	3045	8	836	15	1982	15	**<.001**
	2	20,222	55	2789	50	6215	45	
	≥3	13,241	36	1998	35	5465	40	
Caries experience at 7 years of age	No	33,431	78	3953	60	11,814	76	**<.001**
	Yes	9707	22	2608	40	3746	24	

SGA: small for gestational age.
Figures in bold: $p<.05$ in the chi-squared test.

Figure 1. Mean caries experience (decayed, extracted, filled teeth – deft) of the children by maternal age at delivery.

income, maternal educational level, maternal migration background, family situation, maternal smoking and obesity, SGA, and number of children in the family. When comparing mothers aged 25–34 years with young mothers (<25 years), the risk indicator for caries experience in the offspring of the young mothers was significant (β 0.2; 95% CI: 0.2–0.3); similarly, comparisons with older mothers (>34 years) also yielded a significant risk for caries experience in the offspring of the older mothers (β 0.1; 95% CI: 0.1–0.2).

The results revealed a clear U-shaped association between maternal age at childbirth and dental caries in the offspring. When compared to mothers aged 30–35 years: children of younger mothers (≤20 years) had a higher chance of caries experience (β 0.49; 95% CI: 0.38–0.59). This risk decreased for mothers aged 20–25 years (β 0.16; 95% CI: 0.11–0.21); but there was an association (p=.698). The association between maternal age and caries experience at age 7 years appears again: mothers between ages 35 and 40 years were positively associated with caries in their children (β 0.10; 95% CI: 0.01–0.15), and this association increased in mothers over 40 years (β 0.289; 95% CI: 0.18–0.38; Figure 2).

Table 2. Linear regression: maternal age at delivery, caries experience (deft scores) at 7 years of age and control variables.

Category	Crude β (95% CI)	Model I (95% CI)	β Model II β (95% CI)	Model III β (95% CI)	Model IV β (95% CI)	Model V β (95% CI)	Model VI β (95% CI)	Model VII β (95% CI)	Model VIII β (95% CI)	Model IX β (95% CI)
Maternal age at delivery										
25–34 years	1	1	1	1	1	1	1	1	1	1
<25 years	0.6 (0.6:0.7)	0.6 (0.6:0.7)	0.5 (0.5:0.6)	0.34 (0.3:0.4)	0.3 (0.2:0.3)	0.2 (0.2:0.3)	0.2 (0.2:0.3)	0.2 (0.2:0.3)	0.2 (0.2:0.3)	0.2 (0.2:0.3)
>34 years	0.1 (0.1:0.1)	0.1 (0.1:0.1)	0.1 (0.1:1.1)	0.1 (0.1:0.1)	0.1 (0.1:0.1)	0.1 (0.1:0.1)	0.1 (0.1:0.1)	0.1 (0.1:0.1)	0.1 (0.1:0.1)	0.1 (0.1:0.2)
Sex										
Boy	1	1	1	1	1	1	1	1	1	1
Girl	−0.1 (−0.1:−0.1)	−0.1 (−0.1:−0.01)	−0.1 (−0.1:−0.1)	−0.1 (−0.1:−0.1)	−0.1 (−0.1:−0.1)	−0.1 (−0.1:−0.01)	−0.1 (−0.1:−0.1)	−0.1 (−0.1:−0.1)	−0.1 (−0.1:−0.1)	−0.1 (−0.1:−0.1)
Family income										
>20%	1	–	1	1	1	1	1	1	1	1
≤20%	0.6 (0.54:0.59)	–	0.4 (0.4:0.4)	0.3 (0.3:0.4)	0.2 (0.1:0.2)	0.2 (0.1:0.2)	0.2 (0.2:0.2)	0.2 (0.1:0.2)	0.2 (0.2:0.2)	0.2 (0.1:0.2)
Maternal educational level, years										
>9	1	–	–	1	1	1	1	1	1	1
≤9	1.1 (1.0:1.1)	–	–	0.9 (0.8:0.9)	0.6 (0.5:0.6)	0.5 (0.5:0.6)	0.5 (0.5:0.6)	0.5 (0.5:0.6)	0.5 (0.4:0.5)	0.5 (0.4:0.5)
Foreign-born mother										
No	1	–	–	–	1	1	1	1	1	1
Yes	1.2 (1.2:1.2)	–	–	–	1.0 (1.0:1.1)	1.0 (1.0:1.1)	1.0 (1.0:1.1)	1.0 (1.0:1.1)	1.0 (1.0:1.1)	1.0 (0.9:1.0)
Maternal smoking in early pregnancy										
No	1	–	–	–	–	1	1	1	1	1
Yes	0.5 (0.4:0.5)	–	–	–	–	0.4 (0.3:0.4)	0.4 (0.3:0.4)	0.3 (0.3:0.4)	0.3 (0.3:0.4)	0.3 (0.3:0.4)
Maternal obesity in early pregnancy										
No	1	–	–	–	–	–	1	1	1	1
Yes	0.4 (0.3:0.4)	–	–	–	–	–	0.2 (0.1:0.2)	0.2 (0.1:0.2)	0.2 (0.1:0.2)	0.2 (0.1:0.2)
Family situation										
Cohabiting	1	–	–	–	–	–	–	1	1	1
Single mother	0.3 (0.3:0.3)	–	–	–	–	–	–	0.2 (0.1:0.2)	0.2 (0.1:0.2)	0.2 (0.1:0.2)
SGA										
No	1	–	–	–	–	–	–	–	1	–
Yes	0.1 (0.1:0.2)	–	–	–	–	–	–	–	−0.1 (−0.1:0.1)	–
Number of children per family										
1	1	–	–	–	–	–	–	–	–	1
2	−0.1 (−0.2:−0.1)	–	–	–	–	–	–	–	–	0.1 (0.1:0.1)
≥3 children	0.3 (0.2:0.3)	–	–	–	–	–	–	–	–	0.3 (0.3:0.4)

SGA: small for gestational age.

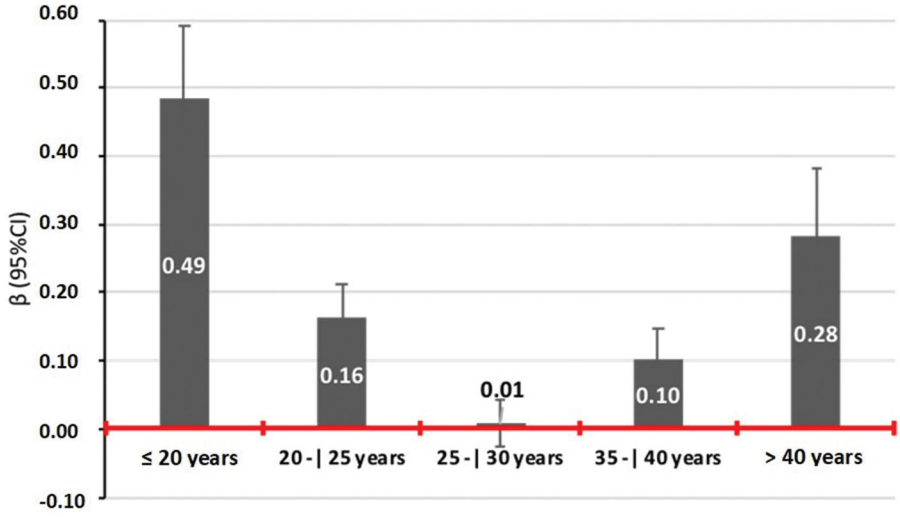

Figure 2. Association between maternal age group and caries experience (decayed, extracted, filled teeth – deft scores) in the offspring at age 7 years.

Discussion

The present study adds new knowledge on the correlation between maternal age at childbirth and child health outcome. We found that caries experience in 7-year-old children has a clear U-shaped correlation with maternal age at childbirth. Children born to younger mothers (<25 years) and older mothers (>34) have higher risks of caries experience than children born to mothers aged 25–34 years.

In the past, the families of children born to older mothers tended to have larger numbers of children and belong to a lower-than-average income class; today, however, these mothers tend to have fewer children and be above average socioeconomically, often because the mothers postpone children in favour of education and becoming established in a professional occupation [22]. Goisis et al. reported that the association between advanced maternal age and the cognitive ability of the children had changed. In earlier birth cohorts, between 1958 and 1970, advanced maternal age at child birth was associated with lower cognitive ability in the offspring whereas in the 2000–2002 cohort, it was associated with better cognitive outcomes [23]. On the other hand, older mothers are at a higher risk of obesity, diabetes, hypertension and associated pregnancy outcomes. These mothers also have a higher risk of adverse birth outcomes such as stillbirth, preterm birth, macrosomia, and being very large for gestational age, despite controlling for higher socioeconomic status [24].

Teenage childbearing is related to low educational levels, single parenthood, substance misuse, and a dependency on social welfare [20]. In addition, children of young mothers have higher levels of premature death due to violence and substance misuse compared with those of older mothers [25]. The adolescent period is normally associated with experimentation and a certain degree of risk-taking behaviour, but parenting teenagers seem to differ from their non-parenting peers by taking greater risks and being involved in serious problem behaviour [26], which might, in turn, put their children at particular risk for injuries.

Both smaller [11] and larger [14,27] cohort studies have found that young maternal age is a risk indicator for dental caries in the offspring. Our results are in line with a study from Singapore [13] that showed that mothers older than 34 years had children with significantly higher caries prevalence at age 2 years compared to mothers below 34. The Singapore study speculated that older mothers have a higher risk of having children with low birth weight, which is associated with a higher risk of enamel defects in the primary dentition, possibly increasing caries susceptibility [13]. Most studies in the literature on pre-school children found no association between low birth weight and dental caries [28]. Recently, however, our research group found that children who were born SGA to non-smoking mothers had a higher risk of dental caries at 3 years of age; however, despite the large cohort in the present study, we found no significant association between low birth weight and dental caries in 3-year-olds [29].

In this study, we found a U-shaped relationship between maternal age and caries experience in offspring at 7 years of age. This relationship is in line with many other health outcomes in children that follow a similar U-shaped relationship [4,5]. The most likely explanation for this is that young mothers, <20 years, more often are socially disadvantaged and their children more often experience adverse childhood conditions such as low education level, unemployment and financial difficulties. Being a single parent also affects parent and child interactions negatively. Higher maternal morbidity, such as obesity, diabetes and obstetric complications, often explains the poorer health among children to older mothers, those >35 years of age [4,21,25]. Hence, with regard to dental caries, poor socioeconomic conditions explain the higher caries experience in younger mothers [14], while higher birth order contributes to the higher caries experience in children of older mothers [16].

Conceptual models of child oral health incorporate factors on many levels: the community, the family and the child [10,30]. Family-level influences include socioeconomic status, family function, health behaviours, practices and coping skills

as well as family composition, such as single parenthood. The present study indicates that family composition needs to be expanded beyond single parenthood to also include maternal age at delivery as a risk indicator associated with dental caries in the offspring.

The main strengths of this registry-based study lie in its coverage of the entire population of Stockholm County, with results for four maternal age groups. We used the Swedish MBR to study maternal age in relation to caries experience at 7 years of age, linking information between registries, and achieved almost complete coverage of children in different family situations. The main advantage of the MBR is the near complete coverage of deliveries in Sweden (97–99%) [31]). In addition, all information about the family was collected independent of the study outcomes, which reduced problems with recall and interviewer bias but still made it possible to adjust for potential confounding factors. One limitation is that data on important risk factors for caries development such as dietary and oral hygiene habits, however, are not available in national registries in Sweden. Another limitation in our register-based study is the risk of random errors due to over- or under-reporting of manifest caries because the examiners could not be calibrated. However, random errors shrink with increasing study size and eventually reach zero when a study becomes infinitely large [32].

The public health implications of this study include a need for further development of measures that support socially disadvantaged young mothers and children; these would include early preventive measures and more long-term support. Among older mothers, above age 34, there is a need to increase awareness that the higher the birth order of the child, the higher the risk for dental caries.

In conclusion, the present study found a U-shaped relationship between maternal age at childbirth and caries experience in the offspring at the age of 7. The offspring of younger mothers and older mothers have a greater risk of having more teeth with caries experience. It is important to explore the social situation of young mothers and direct effective support to where it is needed. It is also clear that older mothers are usually responsible for larger families and that they may need support in managing the oral health of their children, particularly the oral health of later-born children.

Acknowledgements

Statement of ethics: The Regional Ethics Board in Stockholm and the Swedish Data Inspection Board, a national agency that serves as an institutional review board for studies using database linkage, approved the protocol for this study. The authors have no ethical conflicts to disclose.

Author contributions

F.C.S., G.D., and A.J. contributed to the study design; F.C.S., G.D., A.H., A.J. undertook data acquisition and analysis; F.C.S., G.D., A.H., and A.J. contributed to data interpretation, manuscript writing, and critical revision of the manuscript.

Disclosure statement

The authors have no conflicts of interest to declare.

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ORCID

Fernanda Cunha Soares http://orcid.org/0000-0001-6465-3164

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