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Home ownership, income and oral health of children in Australia – A population-based study

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Conflict of Interest: None declared

Contributor's statement

Ludmila Fleitas Alfonzo contributed towards acquisition of data, data analysis, interpretation of results and leading the manuscript preparation.

Rebecca Bentley contributed towards conceptualisation of the study, interpretation of results and revisions of the manuscript.

Ankur Singh contributed towards conceptualisation of the study, analysis plan, interpretation of the results and oversaw the preparation of the manuscript.

All authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

Abstract

Objective: Income inequalities in children's oral health have been well described. It is plausible that the security of tenure reflected by the ownership status of children's housing dynamically interacts with household income to shape these inequalities. We examined if housing tenure modifies the known association between household income and oral health.

Methods: Data were analysed on 3,344 10-11-year-old children from the Longitudinal Study of Australian Children. Multivariable regression models tested associations between household income and dental caries and tooth loss due to caries. Effect modification by home

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ownership (yes/no) was tested on the additive and multiplicative scales. Models were adjusted for sex, Indigenous status, main language spoken at home, area of residence, main carer education and family arrangement.

Results: Children in households in the lowest income group had worse oral health than children in the highest group for caries and tooth loss. Models only weakly supported an additive interaction for tooth loss i.e. the relative excess risk due to interaction (RERI) for low household income was -0.903 (-2.38; 0.571) for tooth loss and -0.076 (-0.42; 0.271) for dental decay, although we note that the low proportion of children from low income homeowning households (6%) reduces the power to detect interactions. Notably, our models suggest renters in both high- and low-income categories had the highest risk of tooth loss compared to owners (RR for high income renters: 2.19 (95%CI: 1.25, 3.85); RR for low-income renters: 2.11 (95%CI: 1.42, 3.16)).

Conclusion: Our study confirms that children in low-income households have poorer oral health outcomes than their high-income counterparts. Our findings additionally suggest that children in rental households may fare the worst of all housing and income combinations considered. Improving the security of housing for families privately renting, may have wider health benefits that currently acknowledged.

Keywords: Australia; health inequalities; housing tenure; income; children; oral health

Introduction

Oral diseases are estimated to affect about 3.5 billion people worldwide. It is estimated that almost one in four children aged between five and fourteen years will experience dental caries (tooth decay).[1] Income is a well-known, but less well understood, social determinant of dental caries among children.[2] Household income is a measure of material resources for health during childhood.[3] A strong gradient in dental caries by household income is confirmed across many countries.[4-6]

Low income restricts access to timely and preventative oral healthcare, a key protective factor for dental caries among children.[7-10] The low uptake of dental services among socially disadvantaged children and limited access to non-cariogenic (low free-sugar) diet are other competing explanations in countries with public dental care.[11,12]

Housing tenure has been used as a marker of material circumstances of children.[3] For low income families, the cost of housing can sometimes deter them from accessing regular health

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care.[13] First, housing is the largest expenditure of most households. It is most often paid first, before other household expenses.[14] In tandem with income, therefore, the cost of housing has the potential to affect children's health by reducing disposable income and restricting a household's capacity to meet health care costs.[15] Second, housing can operate by locating families geographically and thereby determining their access to resources within their communities with a strong correlation between socio-economic position and the quality of health-related resources available locally. [16] Indeed, housing cost and stability have been identified as important protective factors for dental caries in a cross-sectional study of Brazilian children.[17]

In Australia, most families live either in mortgaged houses (68%) or renting from a landlord (25%) or government authority (4%).[18] Each tenure type may impact a household's access to services differently due to the amenity and stability they are able to provide families. Research evidence suggests that homeownership provides socio-economic and ontological security to families and locates them stably in place.[19] This may correlate to more regular use of services in their communities, including dental services. However, for lower income families where their household budget is absorbed by mortgage payments there may be little income left for relatively expensive, non-emergency health care. Further, as home ownership is seen as an investment in the future, there is more incentive for owners to prioritise channelling income into acquisition of housing. Families renting from a landlord, on the other hand, have more flexibility and choice in terms of the cost and location of their housing. However, like ownership, if the cost of renting is too high relative to their income, households in private rental may also curtail their expenditure on health care such as dental visits for preventive reasons but they may also decide to reduce their housing costs by moving (harnessing the flexibility of the tenure).

It is plausible therefore, that children's risk of dental caries is jointly shaped by both the socio-economic dimension of household income and security dimension of people's housing tenure. This is important because the effect of an intervention to increase use of dental services may be amplified by such contextual factors, or may be only beneficial in some population sub-groups.[20,21] Ours is the first study to examine whether the relationship between household income and dental caries (including consequent tooth loss) in Australian children is different for homeowners and non-homeowners (henceforth referred to as renters) using data from a longitudinal study of Australian children (2010 to 2014). This knowledge

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will enable more nuanced oral health promotion activities and increase our understanding of the dynamics of inequalities generation.

Methods

Study population

3,595 children aged 10 to 11 years who participated in the nationally representative Longitudinal Study of Australian Children (LSAC) between 2010-2014. LSAC comprises two cohorts (B with children who were born between March 2003 and February 2004 and K with children born between March 1999 and February 2000). In alignment with our research focus on children, we used data from Cohort B only. LSAC has been well described.[22,23] Children lost to follow up and those with missing data were excluded from the analyses (n=420).

Measures

Exposure

Household income was derived from imputed weekly household income (after tax deduction) as reported by the child's main carer. Weekly household income was categorised into a binary variable (high/low) based on the median household income. The median household income in LSAC was 2050 Australian Dollars (AUD) in 2012.

Effect modifier

Housing tenure was assigned based on parent's response to the question "Is this (house/flat/unit etc.) owned or partly owned by (you/you and Parent 2)?". If the answer was yes, they were considered homeowners. If no, they were considered to be in another tenure, primarily private renters known to be the next most prevalent tenure in Australia to ownership.[18]

Outcome

Dental caries in the past two years was derived from the parent's response to: "…study child had experience of dental decay in the last two years" and "…study child had teeth pulled out due to dental decay in the last two years". Both were categorised as binary variables (yes/no).

Other covariates

Models were adjusted for likely confounding factors of the relationship between income and oral health, income and housing tenure and housing tenure and oral health as described in Figure 1. These included sex (male/female), Indigenous status (yes/no), main language

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spoken at home (English and other than English), area of remoteness (major cities, inner regional, outer regional and remote/very remote) main carer educational attainment (year 12 completed/uncompleted) and family arrangement (one or two parents at home). To assess the causal association between household income and oral health outcomes, a temporal ordering of confounding factors (2010), exposure and effect modifier (2012) and outcomes (2014) was implemented, capitalising on the longitudinal nature of the data.[20]

Statistical analyses

Multivariable regression models were fitted to test the association between categories of household income and each oral health outcome (dental decay/caries and tooth loss due to dental decay/caries) and effect modification by home ownership. Modified Poisson regression was used to estimate relative risks of dental caries and tooth loss.[24] We report risk ratios for both outcomes.[25]

Two sets of models were estimated. The first set of models included unadjusted estimates of the association between household income and oral health outcomes. The second set of models adjusted for child demographic confounders (sex, Indigenous status, main language spoken at home and area of residence) and parental socio-economic confounders (main carer educational attainment and family arrangement).

To examine effect measure modification of the relationship between income and oral health by home ownership four steps were taken. First, we examined the joint effect of household income and home ownership on oral health outcomes by creating a variable that combined categories of homeowners and household income and including this in regression models in place of the income and homeownership variables. Second, the adjusted prevalence of each oral health outcome derived from each fully adjusted model was plotted for each of the combined category of income and home ownership. This facilitated visual inspection of variation in outcomes across categories defined by combinations of income and home ownership. Third, we stratified each model of the relationship between income and oral health by homeownership categories. Bootstrapping with 1000 replications was used to calculate 95% confidence intervals (CIs).

Finally, we quantified the direction and magnitude of effect modification on both multiplicative and additive scales using estimates obtained from regression models that included a statistical interaction between income and homeownership.[26] All models testing statistical interaction were fully adjusted for confounding. To examine effect modification on

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the additive scale, the relative excess risk due to interaction (RERI) with 95% CIs was calculated using 1000 bootstraps.[20,27] RERI is a standard measure for interaction in the additive scale and is calculated as follows:

$$RR_{11} - RR_{10} - RR_{01} + 1$$

Where RR_{11} indicates relative risk for oral health outcomes among both low income and renters, RR_{10} indicates relative risk for oral health outcomes among participants with low income and homeowners and RR_{01} indicates relative risk for oral health outcomes among those with high income and renters.

If RERI is > 0, we have positive additive interaction and when is <0 we have negative additive interaction.[26]

Interactions on the multiplicative scale were determined by ratio of relative risks. A ratio equal to 1 indicates there is no interaction on multiplicative scale.[26]

Data was analysed using the statistical software STATA v15.

Ethical considerations

LSAC data collection was approved by the Human Research Ethics Committee of the Australian Institute of Family Studies.

Results

The total number of children aged 10 to11 years of age in the final sample was 3,344 (Supplementary figure 1). Twenty-six per cent of children experienced dental caries in the last two years and 6% experienced tooth loss. Table 1 shows the distribution of the variables in the sample. Most children lived with two parents (90%). Most of the parents reported owning their homes (79%) and had finished high school (74%). Indigenous Australians reported the lowest proportion of home ownership (49% compared to 79.5% in their non-Indigenous counterparts). On average, median household income was higher for homeowners compared to people in other tenures ($2220 and $1449 respectively), children without dental decay ($2105) and tooth loss ($2086) than children with dental decay ($1948) and tooth loss ($1761).

Dental Caries

In unadjusted analysis, the risk of dental caries was higher for children in low income families (RR: 1.21; 95%CI: 1.08, 1.36) compared with the high-income group (Table 2). The

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association was attenuated in the fully adjusted model to a risk ratio of 1.12 (95%CI: 0.99; 1.27) in the lowest income category.

Tooth loss

Absolute differences in the distribution of tooth loss were small (Supplementary Table 1), with a 2.5% of excess risk of tooth loss in low household income children (95%CI: 0.07; 4.08). Differences on the relative scale were larger. Unadjusted risk ratios for children from low-income households were 1.76 (95%CI: 1.31, 2.35). In the fully adjusted model, risk of tooth loss was higher by 66% (RR: 1.66; 95%CI: 1.22, 2.25) in children living under the household income median.

Effect modification by home ownership

Figure 2 shows the adjusted prevalence of oral health outcomes across income-tenure categories. The adjusted prevalence of dental caries was highest in renters in high and low-income children. Children from homeowner families in the highest income category had the lowest prevalence of dental caries (23.7%). Adjusted proportion of dental caries for children from the renter's category showed wide 95% confidence intervals providing wide uncertainty around the association between household income and dental caries.

Adjusted prevalence of tooth loss showed a lower proportion but a similar distribution of outcomes across tenure and income categories as dental caries. The lowest proportion of tooth loss was observed in children from homeowner families with the highest income (3.59%). There was considerable uncertainty in the association between tooth loss and household income in the children of families in rental tenure.

Table 3 displays estimates of the effect of home ownership in the association of household income and oral health outcomes. Risk of tooth loss was higher among renters at high income (RR 2.19, 95% CI: 1.25, 3.85) and low income (RR 2.11, 95% CI: 1.42, 3.16) than in children of homeowners in the high-income category. For dental caries, risks were slightly greater for low income households (RR of 1.13 for homeowners and 1.15 for renters). However, these estimates had wide uncertainty (95%CI for homeowners: 0.99,1.30; 95%CI for renters: 0.97;1.37).

Oral health status was on average worse in low household income children among homeowners (RR: 1.51 for dental caries and RR: 1.91 for tooth loss). Among renters, associations between oral health outcomes and household income were unsupported in our

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models (RR: 0.99 (95%CI: 0.75; 1.31) for dental caries and RR: 0.86 (95%CI: 0.48; 1.54) for tooth loss).

Both additive and multiplicative interaction were weakly supported in our models. The RERI for each model suggested a departure from the sum of effects of low income and being renter, whereby the effect of income on the two outcomes was higher among the homeowners than renters. The confidence intervals suggested considerable uncertainty in RERIs particularly for dental caries than tooth loss. Therefore, effect modification on additive scale was inconclusive. Effect measure modifications on multiplicative scale for both outcomes showed a similar trend, suggesting only partial evidence of differences in relative inequalities for income between the homeowners and renters, 0.93 (95%CI: 0.69, 1.26) for dental caries and 0.53 (95%CI: 0.27, 1.02) for tooth loss.

Discussion

Our study found high prevalence of dental caries in 10-11 years old children. Our analyses confirm low household income to be associated with higher risk of both dental caries and tooth loss; consistent with literature.[4,28-32] Our analyses showed that children living in rental properties were at higher risk of tooth loss in both income groups. Our models only weakly supported the presence of effect modification by homeownership in the association between household income and child oral health.

Income inequalities in oral health could be attributed to socio-economically patterned rates of sugar consumption and low uptake of public dental care.[7,8,11,12] The particularly marked income gradient for tooth loss might be due to the pattern of oral care seeking in low-income families who may postpone dental visits until the pain becomes evident, and the tooth destruction is severe.[33]

Notably, we identified that children from renters were at higher risk of tooth loss in both income categories. This might be due to the lower average income on rental households as compared to homeowners (even within income bands). Another reason might be more stable access to health care for children in homeowning households. Children living in rental properties are more likely to experience unstable housing and therefore, unstable access to health care. Evidence suggests regular preventive visits with same dentists have beneficial effect on prevention of dental caries.[34] It may be that children living in owned properties have more stable access to continuing dental visits, which facilitates patient's follow-up, thus increasing the benefits of preventative measures.

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Targeted oral health policies in Australia are conditioned on a number of family tax benefits and do not account for other factors such as stability of housing. For example, eligibility for the child dental benefit scheme (CDBS) is dependent on family income, disability or Indigenous status.[35]

This study has many strengths. First, we used of a population-based sample that was highly representative of the Australian population adds to the external validity of the findings. Second, we used longitudinal data with temporally ordered variables that enabled controlling for confounding factors occurring prior to the exposure in the association between income and oral health outcomes.

Nevertheless, these results should be interpreted in the context of some limitations. The models only analysed income at one time point, which did not allow for examining the effect of income on oral health over time. The differential association between tooth loss and dental caries with household income could also be attributed to the accuracy of parent-reported data. Parent-reports of children tooth loss might be more accurate than the report of dental caries. Dental caries could be underreported, given that early enamel lesions related to dental caries could go unnoticed without a clinical diagnosis. On the contrary, to assess the experience of tooth loss, main caretakers were asked whether the study child had a tooth pulled out due to decay, which implies a clinical diagnosis of dental caries by a general dentist. However, the proportion of both oral health outcomes were similar to the one reported in the last Australian National Child Oral Health Study,[30] which indicates that the data was representative of the population.

Information about permanent and primary dentition was not provided which could bias the report of tooth loss. However, parents were explicitly asked if the child lost a tooth due to decay; therefore, the risk of bias due to misclassification was controlled to some extent. Information about the number of teeth affected by dental caries, and the number of teeth lost was also not provided. Thus, this study does not provide information about the severity of dental caries.

The limited number of high-income children in the category of renters limited statistical power to estimate the effect of homeownership in the association between household income and oral health. We addressed this limitation by using a median cut-off for household income, which allowed to increase the number of renters in the low-income category and make comparison between groups. Nevertheless, the number of renters in the high-income category

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remained low. This resulted in large confidence intervals after stratification, providing inconclusive evidence for interaction between income and tenure. We recommend that further research address this limitation.

In conclusion, first, our study has confirmed the persistent and negative association between household income and tooth loss due to dental caries in Australian children. The relationship between household income and dental caries in children was weaker than the association with tooth loss in both homeowners and renters. Second, we did not find strong evidence that the relationship between household income and tooth loss of children varies by housing tenure. Income effect on oral health outcomes was lower in renters than homeowners, but the estimates had considerable uncertainty. Therefore, this interpretation should be made cautiously, and future studies must investigate this for consistency in evidence. Overall, our findings suggest that other contextual factors (e.g. stability of tenure) should be considered together with household income when designing and targeting interventions to reduce social inequalities in oral health.

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Figure 1 – Directed Acyclic Graph (DAG) – (*2 columns fitting image*)

Figure 2. Model predicted prevalence of dental caries and tooth loss – (*1.5 columns fitting image*)

Footnote: *Adjusted for sex, Indigenous status, area of residence, main carer educational attainment, main language spoken at home and family arrangement.

Table 1. Distribution of variables according to household income and home ownership (n=3344)

	n (%)	Income median (IqR)	% homeowners
Sex			
Female	1612 (48.2)	2066 (1435)	80
Male	1732 (51.8)	2036 (1531)	77.5
Indigenous status			
Non-Indigenous	3256 (97.4)	2066. (1471)	79.5
Indigenous Australian	88 (2.63)	1603 (1280)	48.9
Main language spoken at home			
English	3086 (92.3)	2066 (1472)	78.4
Other than English	258 (7.7)	1868 (1454)	82.2
Area of remoteness			
Major Cities	2117 (63.3)	2181 (1562)	80.1
Inner Regional	785 (23.5)	1860 (1188)	76.8
Outer Regional	389 (11.6)	1818 (1473)	76.6
Remote/Very Remote	53 (1.58)	2296 (1339)	64.1
Study child has 2 parents at home			
Yes	3000 (89.7)	2169 (1435)	82.3
No	344 (10.3)	950 (979)	46.8
Main carer high school completion			
Yes	2464 (73.7)	2214 (1523)	82.1
No	880 (26.3)	1663 (1287)	69.5
Study child had dental caries			
No	2479 (74.1)	2105 (1547)	79.7
Yes	865 (25.9)	1948 (1400)	75.8
Study child tooth loss			

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No	3157 (94.1)	2086 (1491)	79.2
Yes	187 (5.59)	1760 (1192)	69
Household income			
High	1667 (50.1)	2871 (1380)	88.9
Low	1667 (49.9)	1378 (781)	68.4
Home ownership			
Yes	2631 (78.7)	2220 (1488)	
No	713 (21.3)	1449 (1243)	

Table 2. Multivariable regression analysis for the association of household income and oral health outcomes.

	Dental caries – RR (95%CI)		**Tooth loss – RR (95%CI)**	
Household income	**Crude estimate**	**Fully adjusted estimate***	**Crude estimate**	**Fully adjusted estimate***
High	**ref**	**ref**	**ref**	**ref**
Low	1.21 (1.08; 1.36)	1.12 (0.99; 1.27)	1.76 (1.32; 2.35)	1.66 (1.22; 2.25)

*Adjusted for demographic variables (sex, Indigenous status, main language spoken at home and area of residence) and parental socioeconomic variables (main carer educational attainment and family arrangement)..

Table 3. Modification of the effect of household income in oral health outcomes by home ownership in children aged 10-11 years (n=3344)

DENTAL CARIES				
Stratum-specific estimates of risk of dental caries				
	High household income		**Low household income**	
Housing tenure	**n with/ without**	**RR (95% CI)**	**n with/ without**	**RR (95% CI)**
Owners	343/1148	**ref**	313/827	1.13 (0.99; 1.30)
Renters	50/136	1.09 (0.85; 1.41)	159/368	1.15 (0.97; 1.37)
Risk ratio of dental caries for household income groups within strata of housing tenure				
Tenure	**High household income**		**Low household income RRs (95% CI)**	
Owners	**ref**		1.15 (1.01; 1.32)	
Renters	**ref**		0.99 (0.75; 1.31)	
Relative excess risk due to interaction (95%CI)				
Low household income			-0.076 (-0.42; 0.271)	

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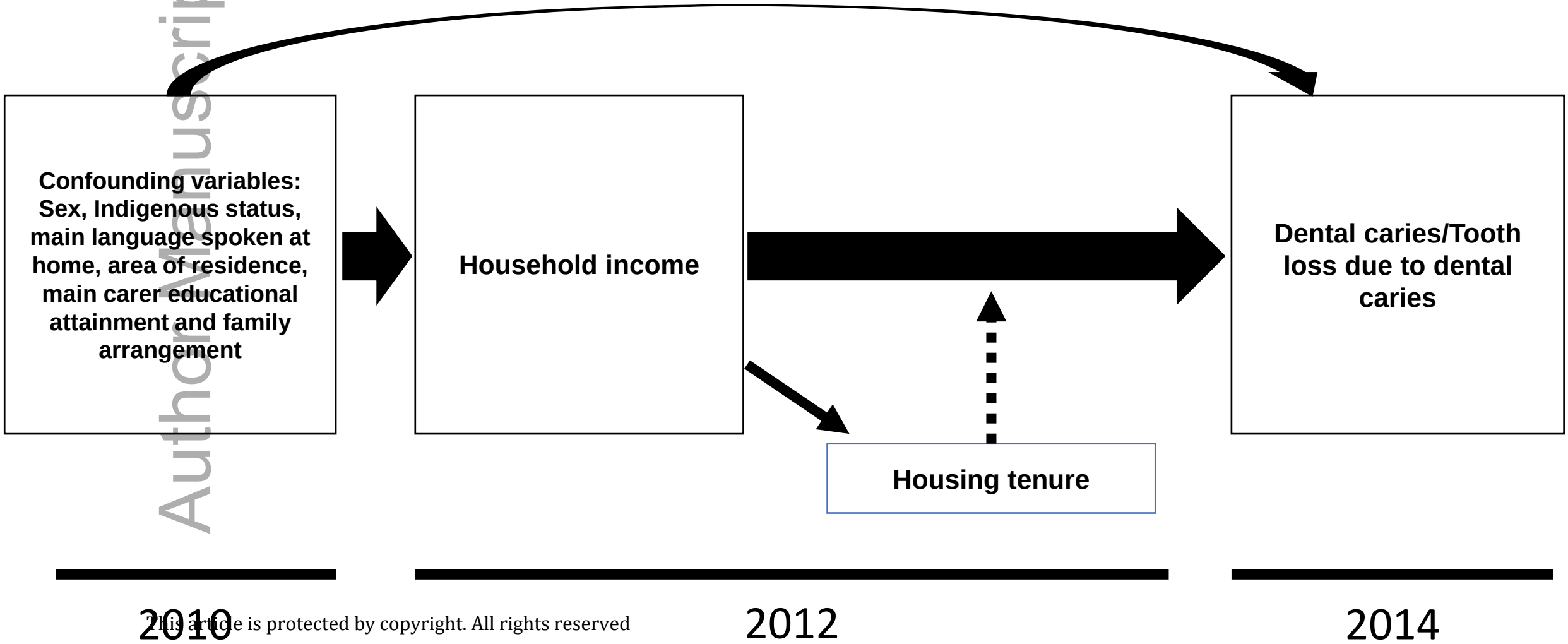
Effect modification on multiplicative scale: Ratios of RR (95%CI)				
Low household income			0.93 (0.69; 1.26)	
TOOTH LOSS				
Stratum-specific estimates of risks of tooth loss				
	High household income		**Low household income**	
Housing tenure	**n with/ without**	**RR (95% CI)**	**n with/ without**	**RR (95% CI)**
Owners	53/1438	**ref**	76/1064	1.82 (1.28; 2.58)
Renters	15/171	2.20 (1.26; 3.85)	43/484	2.12 (1.42; 3.16)
Risk ratio of tooth loss for household income groups within strata of housing tenure				
Tenure	**High household income**		**Low household income RR (95% CI)**	
Owners	**ref**		1.91 (1.34; 2.70)	
Renters	**ref**		0.86 (0.48; 1.54)	
Relative excess risk due to interaction (95%CI)				
Low household income			-0.903 (-2.38; 0.571)	
Effect modification on multiplicative scale: Ratios of RR (95%CI)				
Low household income			0.53 (0.27; 1.02)	

*All models were adjusted for sex, Indigenous status, main language spoken at home, area of residence and main carer educational attainment and family arrangement.

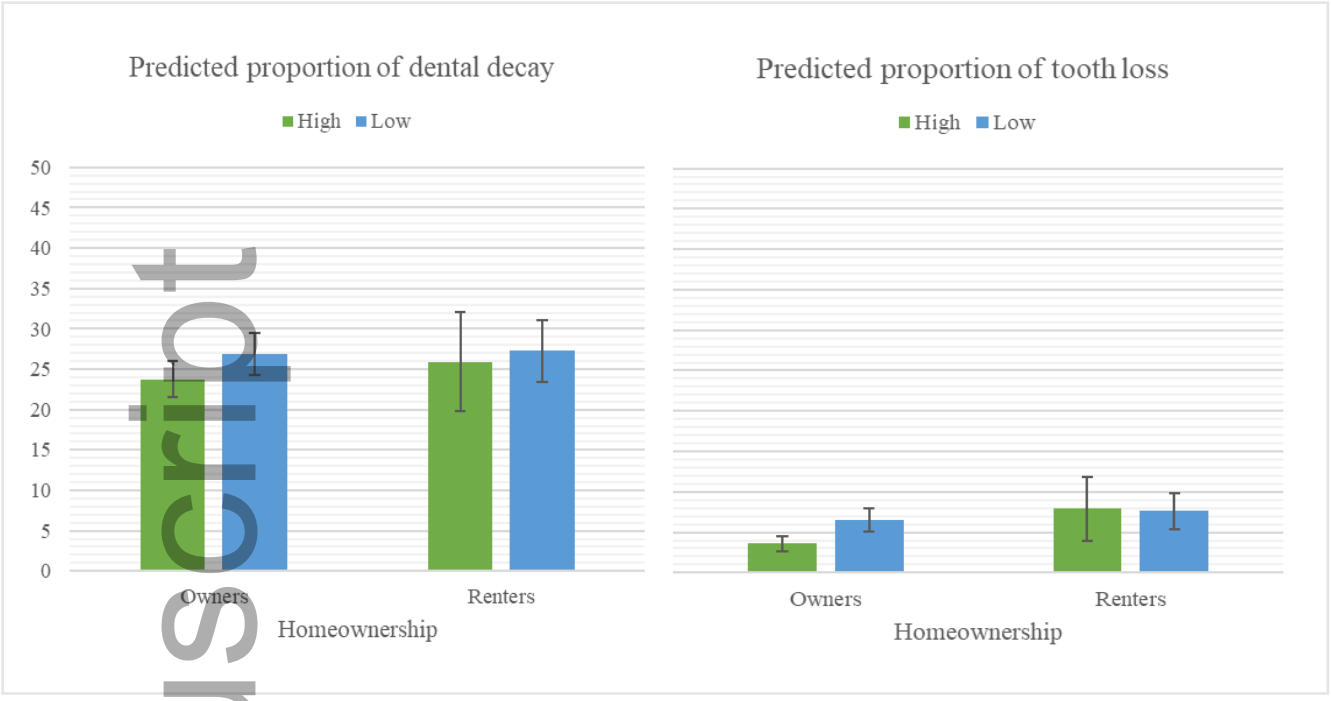
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