Can attending preschool reduce the risk of tobacco smoking in adulthood? The effects of Kindergarten Union participation in South Australia

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Accepted 10 April 2010
Published Online First 27 June 2010

ABSTRACT

Background Innovative strategies beyond the health system are required to reduce the prevalence of smoking. Early child development interventions are examples of interventions that can help set children on positive social and educational trajectories, which in turn may also reduce the prevalence of smoking. The aim of this study was to examine the effect of attendance at Kindergarten Union preschools on tobacco smoking in adulthood.

Methods Kindergarten Union preschools delivered comprehensive services to children and their families, including education, parenting and health services, with a number of features consistent with contemporary ideas of high-quality service delivery. Using a retrospective cohort design with data from the North West Adelaide Health Study, this study examined different aspects of smoking behaviour in adults aged 34—67 years who attended a Kindergarten Union preschool at some stage between 1940 and 1972. Data were analysed using generalised linear model poisson regression with robust variance estimates, adjusting for both child and adult socio-economic factors and history of parental smoking.

Results People who attended preschool had a reduced risk of ever smoking (prevalence ratio 0.87, 95% CI 0.77 to 0.98) and a reduced risk of current smoking in adulthood (prevalence ratio 0.77 (95% CI 0.59 to 1.00)), compared with those who did not attend preschool. There was no effect of preschool attendance on age at smoking uptake, age at quitting or the probability of quitting smoking.

Conclusion Attendance at the high-quality Kindergarten Union preschools was associated with a reduction in the initial uptake of smoking and thus the probability of being a current smoker. Among their other potential social benefits, high-quality, universal preschool programmes have the potential to help reduce smoking prevalence across the population.

INTRODUCTION

Despite past successes in tobacco control, 16.6% of Australians continue to smoke, with an even higher prevalence (25.9%) among the socio-economically disadvantaged.[1] Innovative strategies beyond the health system are required to reduce the prevalence of tobacco smoking further,[2 3] in particular for lower socio-economic groups. Early childhood development interventions (ECDIs) have the potential to help current control efforts to reduce the risk of tobacco smoking. It is believed that these interventions can potentially overcome some of the future negative effect on health of a low socio-economic position (SEP) in childhood by altering educational, social and behavioural trajectories.[4–6] More favourable trajectories of human capital formation through education, occupation and income may also alter the prevalence of tobacco smoking in adulthood.

A small number of high-quality ECDI studies—some of which were randomised trials—have found evidence of a reduced risk of smoking in adulthood for participants. In five out of six studies that examined the risk of smoking for preschool participants, there was a reduction in risk of ever or current smoking in adulthood.[7–12] The two most rigorous randomised trials of ECDIs, both involving highly disadvantaged, predominantly African—American populations in the USA, found an RR of current smoking of 0.76[12] and of ever smoking of 0.71[9] by age 40 and 21 respectively.

Using data from the North West Adelaide Health Study[13 14] (NWAHS), this study aimed to assess the effect of attendance at Kindergarten Union (KU) preschools on a range of smoking outcomes in adulthood. We examined key smoking stages across the life course, which have not been studied in this context previously, such as smoking uptake, age at commencement of smoking, age at quitting smoking and the chance of quitting. A better understanding of these different effects may help clarify the potential for ECDIs as part of a set of population strategies to reduce smoking.

METHODS

Kindergarten Union preschools

The Kindergarten Union managed preschools in South Australia (SA) from 1906 to 1985, and until the 1970s, the KU operated, through branch or affiliated kindergartens, the vast majority of preschool services in South Australia.[15–17] The preschools were initially established to enhance the social, emotional, physical and cognitive development of children who were living in poverty, with an emphasis on educational services.[16] In the initial years of the KU, preschools were established in suburbs with high levels of poverty and were free for socially disadvantaged children, expanding to middle-class suburbs by the 1940s. Attendance was primarily through geographic proximity to an existing centre.

The preschool programme enrolled children between 2 and 5 years old, for half or full days, for up to 5 days a week. The programme involved high-quality, direct educational services for children, parenting services, home visiting and health screening and referral for specialist services when required.[17] There is no record in the historical

literature of any specific health promotion programme undertaken by the KU preschools aimed at reducing smoking uptake in either the children or their parents. The KU preschools included a number of high-quality features. All preschool directors and teachers were required to have a recognised early childhood development qualification, and standards developed by the Australian Pre-School Association were adopted across all preschools.[17 18] In 1945, a 'Pre-school Advisor' was appointed to assist the preschools to adhere to the standards and curriculum set by the KU.[17]

Data

The NWAHS is a longitudinal representative cohort study of adults over 17 years old, randomly selected from the northern and western metropolitan regions of Adelaide using the electronic telephone directory.[13] Within each household, the person with the most recent birthday aged over 17 years was selected for interview. Exclusion criteria included not having the capacity to participate (intellectual, illness), living in a residential institution and being unable to communicate in English.

The sample was recruited from 1999 to 2003. The 4060 participants represented 49.4% of those who were eligible to participate. Data were collected by questionnaire, Computer Aided Telephone Interview (CATI) and clinic attendance in stage 1 (years 1999–2003) and stage 2 (2004), and a telephone follow-up CATI was conducted in 2007 when details of preschool attendance were collected.

Study population

Participants in the 2007 telephone follow-up survey in the NWAHS (n=2996, 74% of baseline population) who lived in SA as children and were born during the years 1937–1969 were included in the study. After application of the inclusion criteria, the overall sample available for analysis was 1395; however, missing data and exclusions restricted the final analytical sample to 1040.

Attendance at a Kindergarten Union preschool

The participants were asked to recall if they had attended preschool in SA, and the age at which they attended. People who indicated that they did not know if they went to preschool were considered to be missing (n=108). The smoking outcome effect sizes for those with missing preschool attendance data were similar to the non-preschool group, except for a slightly greater risk of being a current smoker (prevalence ratios (PR) 1.10, CI 0.75 to 1.64) and lower chance of having quit smoking (PR 0.78, CI 0.56 to 1.10).

Tobacco smoking

Smoking variables were taken from stage 1 or 2 of data collection as detailed below:

ever smoking: report of ever smoking in stage 1 or stage 2;

current smoking: report of current smoking at stage 2, with missing data replaced with report of current smoking from stage 1;

quitting smoking: constructed from the current and ever smoking variables, with all those ever smokers who were no longer current smokers considered to have ceased smoking;

age at smoking uptake: report of age at commencement of smoking in stage 1, with missing data replaced by report of age of commencement of smoking at stage 2;

age at quitting: report of age of ceasing smoking in stage 2 (it was only asked in stage 2);

parental smoking: report of smoking in a parent or guardian when the respondent was 4 years old.

Indicators of childhood SEP

Childhood SEP was measured using report of father's and mother's main lifetime occupation, reported periods of at least 6 months of parental unemployment or being brought up in a sole parent household. Parental main lifetime occupation as recalled by participants is a technique that has been used frequently in the literature[19] and has been shown to be a reasonably valid measure of the childhood socio-economic environment.[20–22] Occupations were coded as manual and non-manual.[23] An index was created that summed the three socio-economic variables such that the index ranged from zero (no marker of disadvantage) to three (maximal marker of disadvantage). An index equal to 2 or 3 was collapsed to one category due to a zero cell in the child social disadvantage index for non-preschool participants. Adult height, which reflects aspects of the early nutritional and socio-economic environment[24] and has the advantage of being precisely measurable, was additionally used as a further indicator of childhood disadvantage.

Indicators of adult SEP

Education was categorised into four mutually exclusive categories (leaving school up to 15 years, leaving school after 15 years, attainment of a trade or diploma and attainment of a bachelor's degree or higher) using self-reported educational attainment from stage 2, replacing missing data with responses from stage 1. Income was analysed using seven gross household income categories as collected in stage 2, from less than $12 000 to over $100 000, excluding people who reported being retired.

Birth cohort effects

An analysis stratified by birth cohort was also undertaken, because the 33-year time period examined in this study involved secular changes in both tobacco smoking and education.[25] Over the years in which the cohort was old enough to smoke, male smoking decreased from 70% in 1950 to 40% in 1980, with a reversal in the social gradient as the social desirability of smoking among higher SEP groups declined.[26] Female smoking, however, remained stable at 30% and 31%, respectively.[26] There were also secular changes in education patterns over this period, as in 1963 the compulsory age for school attendance changed from 13 to 14 years, affecting those born after 1949.[27] Additionally, there was increased access to preschool over time due to social and policy changes. To account for these potential birth cohort effects, three birth cohorts were created for analyses: 1937–1949, 1950–1959 and 1960–1969.

Statistical analysis

The data were analysed using generalised linear model poisson regression with robust variance estimates, with resulting PR for the effect estimate. This modelling method has been recommended for studies with dichotomous outcomes that are relatively common (ie, >10–20%), as in this study.[28] Age at commencement or cessation of smoking outcomes was analysed using a linear regression model.

The association between preschool attendance and smoking outcomes was assessed in sequential regression models. Model 1 adjusted for year of birth (cohort effect), age and gender. Model 2 further adjusted for child SEP and adult height. Model 3 adjusted for parental smoking, and model 4 included educational attainment and adult income.

Absolute risk differences (ARD) in the probability of the outcomes between the preschool and non-preschool group were calculated from model 4 by setting all explanatory variables at their mean values.

To examine if the effect of preschool on smoking changed due to the secular changes in smoking and preschool attendance, the analysis was repeated stratified by birth cohort and gender including all the variables in model 4.

RESULTS

Participant characteristics

Table 1 describes the study population. Respondents were 34–67 years old at follow-up in stage 2 (2004), with an average age for preschool participants of 45.2 years and for non-participants 51.05 years. Preschool attendance increased with each successive birth cohort, and a greater proportion of preschool participants came from a relatively less disadvantaged childhood (60.1% compared with 67.8%). The preschool cohort tended to have a greater proportion of people with a university education and a greater proportion in the higher income groups.

The crude analyses showed there were fewer current and ever smokers in the preschool group, but there was no difference in the age at commencement and cessation of smoking between the preschool and comparison group.

Table 1 Description of the study sample in the North West Adelaide Health Study, 1999–2007*

Variable	Attended preschool n=466 (percentage of n)	Did not attend preschool n=574 (percentage of n)	Percentage of total eligible sample
Age mean (SD)	45.2 (7.60)	51.05 (7.75)	48.4 (8.22)
Male	45.1	46.3	45.8
Birth cohort			
1937–1949	14.8	34.5	25.7
1950–1959	32.2	41.5	37.3
1960–1969	53.0	24.0	37.0
Child socio-economic position index			
0	39.9	32.2	35.7
1	55.4	58.4	57.0
2	4.7	9.4	7.3
Height in cm (SD)	169.8 (9.0)	168.8 (9.46)	169.3 (9.26)
Education			
Left school up to age 15	7.7	15.2	11.8
Left school after age 15	32.6	34.2	33.5
Trade/diploma	39.1	38.2	38.6
Bachelor's degree or higher	20.6	12.5	16.2
Income			
0–$12000	3.4	8.2	6.1
$12001–20000	6.4	5.4	8.9
$20001–40000	20.0	21.8	21.0
$40001–60000	23.8	29.3	26.8
$60001–80000	20.8	18.8	19.7
$80001–100000	12.2	9.9	11.0
>$100000	13.3	6.6	9.6
Parent smoker	69.5	72.0	70.9
Ever smoker	52.6	57.7	55.4
Current smoker	19.5	21.3	20.5
Age at starting smoking in years (SD)	17.4 (4.0)	17.6 (4.11)	17.5 (4.06)
Age at quitting smoking in years (SD)	32.3 (9.04)	33.9 (10.31)	33.2 (9.84)

*Proportion unless otherwise indicated, SD.

Multivariable analyses

Ever smoking

Table 2 displays the results for the multivariable analyses and the adjusted absolute risks by preschool participation for each of the smoking outcomes. Preschool participation was associated with a reduced risk of smoking uptake (PR 0.85, CI 0.75 to 0.95) when birth cohort, age and sex were controlled for, which was only marginally attenuated by addition of childhood SEP variables and parental smoking. Addition of adult SEP variables, potential mediating factors, further reduced the magnitude of the association slightly (PR 0.87, CI 0.77 to 0.98, ARD −7.7%). Despite the limited effect variables such as adult SEP and parental smoking had on the preschool effect sizes, these variables were all strongly related to ever smoking in the expected directions (data not shown). For instance, parental smoking increased the risk in model 4 of the child being an ever smoker with a PR of 1.31 (95% CI 1.14 to 1.5).

Current smoking

There was a reduced risk of being a current smoker for preschool participants, which remained essentially unchanged after accounting for potential childhood confounders (PR 0.74, CI 0.57 to 0.97). A small component of the protective effect of preschool participation was accounted for by adult SEP variables, as was evident in the slight reduction in the protective effect in the prevalence ratio to 0.77 (CI 0.59 to 1.00, ARD −4.3%) in model 4.

Quitting smoking

By contrast with ever and current smoking, there was no evidence to suggest that preschool participation affected the chance of quitting (PR 1.05, CI 0.92 to 1.20, ARD 3.2%).

Age at commencement and cessation of smoking

Similarly, there was no difference in the age at commencement of smoking (β −0.29, CI −1.05 to 0.46, ARD −0.3 years) and/or that preschool participants quit smoking at earlier ages (β 1.43, CI −0.87 to 3.73, ARD 1.4 years).

Stratified analyses

Table 3 displays selected demographic characteristics and smoking outcomes by birth cohort. As expected, the average height across the sample increased from the oldest to the youngest cohort, while the proportion of people from low to high SEP in childhood remained similar over time. The proportion of people by birth cohort who were ever smokers or current smokers increased over time, whereas the oldest cohort had a greater chance of having quit smoking.

Figures 1, 2 summarise the effect of preschool on ever smoking stratified by birth cohort, controlling for age, child SEP, adult height, educational attainment and income. In the oldest birth cohort, men who went to preschool had a higher risk of smoking uptake than those who did not go to preschool (PR 1.73, CI 1.25 to 2.41). However, in subsequent birth cohorts, men who attended preschool had a reduced risk of smoking uptake (eg, PR 0.62, CI 0.46 to 0.83 for those born in 1960–1969). Women who attended preschool tended to have reduced risks of being an ever

Table 2 Multivariable results for the effect of preschool on smoking outcomes in the North West Adelaide Health Study, 1999–2007

Outcome	Model 1	Model 2	Model 3	Model 4	Adjusted absolute risk: preschool*	Adjusted absolute risk: no preschool*	Adjusted absolute risk difference*
Ever smoking n=1040	PR 0.85 (0.75 to 0.95)	PR 0.85 (0.76 to 0.96)	PR 0.86 (0.76 to 0.97)	PR 0.87 (0.77 to 0.98)	50.0%	57.7%	−7.7%
Current smoker n=1040	PR 0.74 (0.57 to 0.96)	PR 0.74 (0.57 to 0.96)	PR 0.74 (0.57 to 0.97)	PR 0.77 (0.59 to 1.00)	14.6%	18.9%	−4.3%
Quitting smoking n=576	PR 1.08 (0.94 to 1.24)	PR 1.09 (0.95 to 1.25)	PR 1.09 (0.95 to 1.25)	PR 1.05 (0.92 to 1.20)	65.2%	62.0%	3.2%
Age at smoking uptake n=520	β to 0.07 (−0.83 to 0.68)	β −0.21 (−0.97 to 0.55)	β −0.20 (−0.96 to 0.56)	β −0.29 (−1.05 to 0.46)	17.5 years	17.8 years	−0.3 years
Age at quitting n=304	β 1.12 (−1.10 to 3.35)	β 1.19 (−1.09 to 3.46)	β 1.19 (−1.08 to 3.47)	β 1.43 (−0.87 to 3.73)	33.8 years	32.4 years	1.4 years

Model 1: adjusted for birth cohort effect, age, gender; Model 2: model 1+child SEP, adult height; Model 3: model 2+parental smoking; Model 4: model 3+educational attainment, adult income; PR, prevalence ratio.
*Calculated following model 4 setting all explanatory covariates to their mean values.

smoker in all birth cohorts (eg, PR 0.89, CI 0.68 to 1.18 for those born in 1960–1969).

DISCUSSION

Attendance at the high-quality, comprehensive KU preschools was associated with a 7.7% reduction in the absolute risk (PR 0.87 (0.77–0.98)) of ever smoking and a 4.3% lower absolute risk of being a current smoker (PR 0.77 (0.59–1.00)), after adjustment for childhood and adult SEP, and parental smoking. Among ever smokers, there was no apparent influence of preschool attendance on age at starting or quitting smoking, or on the probability of quitting smoking. These findings extend the evidence from life course studies of the effects of childhood disadvantage[29] by examining the effects of a specific early life intervention—preschool attendance—while taking into account childhood and adult SEP. The findings also extend results from previous ECDI randomised studies by having assessed the effect of preschool attendance in a large cohort, in a country outside the USA, and into late adulthood, which allowed a greater exploration of factors such as quitting smoking.

Under the assumption that the effects of preschool on smoking shown here are causal, these effects translate into large population gains in tobacco reduction. For example, given a 23% relative reduction in the probability of current smoking in the preschool group and that the contribution of smoking to the total burden of disease in Australia is 7.8%, preschool attendance could lead to a 1.8% reduction in the total burden of disease.[1] Alternatively, the absolute reduction in current smoking of around 4% is larger than the reduction in smoking among adults in Australia over the 10-year period from 1998 (19.2% prevalence) to 2007 (16.1% prevalence).[30] Preschool as a universal programme also has the benefit of reducing uptake rather than focussing on the more costly and less effective quit-smoking programmes. Comparable programmes to encourage quitting (which only work on those who are already smokers) such as physician advice to stop smoking can lead to an increase in quitting of 1–3%.[31]

The finding of an effect of preschool participation on current and ever smoking after controlling for educational attainment and income suggests that the latter adult characteristics accounted for only a small proportion of the observed effect of preschool on smoking outcomes, despite the fact that in fully adjusted models, both higher education and income were associated with reduced risk of ever and current smoking, as would be expected. One strand of evidence suggests that preschool improves long-term outcomes mostly through cognitive gains. Enhanced childhood IQ leads to early school success, which in turn enhances classroom adjustment, motivation and pro-social behaviours.[9 11 32 33] Smoking behaviour is similarly influenced by cognitive factors in childhood including IQ and school achievement, but also by behaviours in childhood, in particular delinquent behaviour and association with role models (parental or peers) who smoke.[34 35]

Table 3 Description of birth cohort differences on demographic characteristics and smoking outcomes in the North West Adelaide Health Study, 1999–2007 (n=1040)

	1937–1949		1950–1959		1960–1969	
Outcome	**n**	**Percentage**	**n**	**Percentage**	**n**	**Percentage**
Age in 2007	58–70	25.7	48–57	37.3	37–47	37.0
Male	121	45.3	176	45.3	179	46.5
Child SEP index						
0	110	41.2	128	33.0	133	34.6
1	137	51.3	228	58.8	228	59.2
2	20	7.5	32	8.3	24	6.2
Height	168.1 cm		169.0 cm		170.3 cm	
Ever smoker	131	49.1	216	55.7	229	59.5
Current smoker	34	12.7	79	20.4	100	26.0
Quit smoking*	97	74.1	137	63.4	129	56.3

*Restricted to ever smokers.

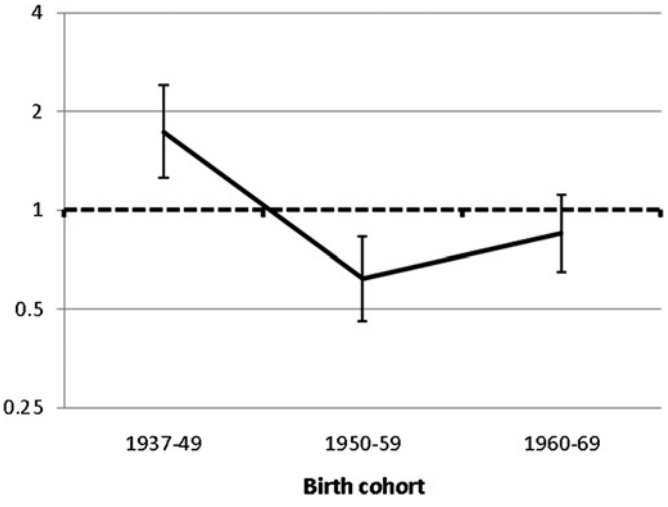

Figure 1 Prevalence ratios for the effect of preschool on ever smoking among men, according to birth cohort in the North West Adelaide Health Study, 1999–2007.

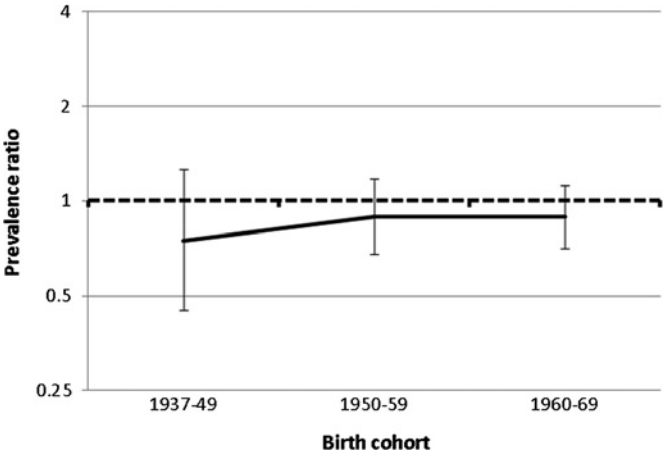

Figure 2 Prevalence ratios for the effect of preschool on ever smoking among women, according to birth cohort in the North West Adelaide Health Study, 1999–2007.

A complementary strand of evidence suggests a role for non-cognitive or personality factors in explaining why ECDIs can benefit health and social outcomes. Heckman argues that non-cognitive skills such as motivation, persistence and tenacity are just as important for success in life as higher cognitive functioning.[36] A recent study of both cognitive and non-cognitive factors showed that non-cognitive factors explained 36%, 45% and 59% of high school completion, highest grade achieved and incarceration history respectively.[37] Additionally, better classroom adjustment, motivation and pro-social behaviours associated with preschool cognitive and non-cognitive gains may lead to preschool participants later associating with similarly pro-social peers and to reduced antisocial behaviours, leading to reduced smoking uptake. It is worth noting that for either or both of these mechanisms to reduce the risk of ever becoming a smoker, these mechanisms would have to operate mainly at ages 12–17 because about 80% of smoking is initiated by age 18.[38]

Preschool appears to have a differential effect on whether a person starts smoking, quits smoking or remains a current smoker. The observed effects of preschool attendance on reduced risk of current smoking likely reflect the lack of association between preschool and quitting smoking, such that the reduced risk of current smoking is because preschool operates through an effect of reducing the risk of taking up smoking, rather than an effect on having started smoking but then quitting. These findings are perhaps not surprising given the determinants of smoking uptake are likely to be different from smoking cessation. Smoking uptake more clearly indexes the childhood environment and so is perhaps more amenable to a childhood educational intervention, while quitting smoking is likely more determined by adult socio-economic and other factors,[2 3] which is possibly relatively less directly influenced by a childhood intervention.

The changing patterns in ever and current smoking over time in the NWAHS data are seemingly counterintuitive, with a higher ever smoking prevalence in younger compared with older cohorts in the setting of a reduction in the population prevalence of smoking over time. However, these findings are consistent with those reported in the Australian National Drug Household Survey on the prevalence of current, ever and quitting smoking indicating the sample is reasonably representative of the history of smoking in Australia. For example, 49% of people aged 60 and over were ever smokers compared with 49.1% of people aged 58 to 70 years in the NWAHS.[39] It is likely that a combination of birth cohort, period and survivorship effects explains these findings, in addition to current smoking indicating the effect of both ever smoking and quitting smoking. The finding of an increased risk of smoking uptake for men (but not women) in the oldest cohort and a reduction in subsequent cohorts is consistent with what would be expected from the known secular changes in smoking prevalence for men over time in Australia. Prior to the widespread messages of smoking being a health hazard, smoking was socially desirable for men (but not women), whereas in subsequent generations, with the increased availability of health messages, high SEP men became less likely to smoke. These findings support the hypothesised pathway of preschool on smoking through enhancing SEP, as men in the oldest cohort exposed to preschool were more likely to smoke when it was common among men of higher SEP and lower in subsequent birth cohorts when men who went to preschool and attained a higher adult SEP would be less likely to smoke.

There is potential for residual confounding by unmeasured and/or poorly measured background characteristics related to family environment in this study. This includes the potential for not adequately controlling for factors that lead to families electing to send their children to a KU preschool, which may also be associated with the risk of future smoking. It is likely that geographic proximity to a centre, which helped determine selection into preschool, is less susceptible to selection bias. The background socio-economic environment is likely to also have been associated with the likelihood of attending preschool which this study attempted to control for by inclusion of adult height, childhood SEP and parental smoking in the models. Additionally, the stratified analysis strengthens the likelihood the association is not entirely due to residual confounding as any unmeasured factor that could account for the association between preschool and ever smoking would need to change over time in the same way that the association between preschool and increased smoking risk changes among the older men but not among women. As in any prospective study, this study has had attrition over time, which may have reduced the representativeness of the study, although the proportion of the sample lost to follow-up was modest (26%). In any event, sample selection and attrition, while losing representativeness, need not bias observed associations.[40]

Measurement error may have been introduced by the use of adult recall of preschool attendance and smoking history. Adult recall of preschool attendance has been used in a number of studies,[7 41 42] and was found in one study that compared historical with recalled preschool participation rates to be reasonably valid.[42] Additionally, the results in this study are consistent with the small amount of evidence on preschool programmes reported elsewhere,[7 9 10 12] suggesting reasonable validity of recall of preschool attendance. A further limitation of the study was the inability to assess the association between preschool attendance and a reduced risk of smoking for a possible dose–response effect, as no adequate data on different dimensions of exposure to preschool (such as number of days of attendance per week) were collected. It is less likely that self report of smoking introduced marked measurement error, as, for example, another large cohort study found high validity of self-reported smoking when compared with measured serum cotinine levels.[43]

This study provides some evidence that a specific early life exposure—attendance at a comprehensive, high-quality preschool programmes—may have the potential to protect against tobacco smoking uptake, in addition to other social

What this study adds

- There is some evidence from a small number of high-quality early childhood development intervention studies of a reduced risk of ever or current smoking in adulthood. Other important stages of smoking across the life course such as age at commencement of smoking, age at quitting smoking and the chance of quitting have not been studied. A better understanding of these different effects may help clarify the mechanisms and potential for early childhood development intervention as a novel long-term strategy to reduce the risk of smoking in populations.
- People who attended preschool had a reduced risk of ever smoking and a reduced risk of current smoking in adulthood. There was no effect of preschool attendance on age at smoking uptake, age at quitting or probability of quitting smoking. Among the other well-described social benefits, universal preschool programmes have the potential to reduce smoking prevalence across the population, predominately through reduced smoking uptake.

benefits described in the literature.[5] Given the limitations of the study, the findings reported here warrant further exploration in other cohort studies or follow-up of large randomised trials in different populations including examining any potential dose–response effect, to enable a greater understanding of the processes involved between ECDIs and adult health outcomes. In particular, examination of non-cognitive links between ECDIs and later health behaviours such as smoking warrants further attention in current cohorts and randomised controlled trials of ECDI. Overall, the results support the proposition that interventions outside the health system have the potential to address the important role that social factors have on the uptake and prevalence of tobacco smoking at a population level. Attendance at high-quality preschool programmes may be an important developmental adjunct to strategies for greater populationwide tobacco control.

Acknowledgements The authors would like to acknowledge the staff and participants of the North West Adelaide Health Study.

Funding KD was supported by the National Health and Medical Research Council of Australia and the National Heart Foundation. JL was supported by the National Health and Medical Research Council of Australia.

Competing interests None.

Ethics approval Ethics approval was provided by the University of South Australia Human Research Ethics Committee and the Central Northern Adelaide Health Service Ethics of Human Research Committee.

Contributors All authors were responsible for the concept and design of the study. KD carried out the analysis with the assistance of RAM and JWL. All authors were responsible for the interpretation of the findings. KD produced the first draft, and all authors were responsible for the critical revision of the manuscript.

Provenance and peer review Not commissioned; externally peer reviewed.

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