Vaccine 32 (2014) 2042–2049

Contents lists available at ScienceDirect

Vaccine

journal homepage: www.elsevier.com/locate/vaccine

Community, parental and adolescent awareness and knowledge of meningococcal disease

Bing Wang[a,b,*], Michelle Clarke[b], Hossein Haji Ali Afzali[c], Helen Marshall[b,c,d]

[a] School of Population Health/Paediatrics and Reproductive Health, University of Adelaide, South Australia, Australia
[b] Vaccinology and Immunology Research Trials Unit (VIRTU), Women's and Children's Hospital, 72 King William Rd, North Adelaide, South Australia 5005, Australia
[c] Discipline of Public Health, University of Adelaide, Level 7, 178 North Terrace, Adelaide, South Australia 5005, Australia
[d] Robinson Institute and School of Paediatrics and Reproductive Health, University of Adelaide, South Australia, Australia

ARTICLE INFO

Article history:
Received 7 December 2013
Received in revised form 6 February 2014
Accepted 12 February 2014
Available online 1 March 2014

Keywords:
Meningococcal disease
Knowledge
Awareness
Survey

ABSTRACT

Objective: To assess knowledge of invasive meningococcal disease (IMD) and concern about the disease in the South Australian Community including adolescents, adults, parents and non-parents.
Methods: This cross-sectional study was conducted by face to face interviews in South Australia in 2012. Participants were scored on their knowledge and concern about IMD. Univariate and multivariate regression analyses were performed with the survey data weighted by age and gender in accordance with 2011 Census data.
Results: Of 5200 households randomly selected and stratified by metropolitan or rural location, 3055 participants were interviewed with a response rate of 60.3%. The majority were Australian born (74.2%, $n = 2267$) with 31.8% ($n = 972$) of those interviewed being parents, and 15.9% ($n = 487$) adolescents (15–24 years). Almost a quarter of participants (23.5%, $n = 717$) do not know what meningococcal disease is, with 9.1% ($n = 278$) believing incorrectly that IMD is a viral infection. 36.6% ($n = 1114$) had low overall knowledge of IMD. Adolescents ($p < 0.050$), non-Australian born ($p < 0.001$), low educational attainment ($p = 0.019$), low household income ($p = 0.011$), low/medium socio-economic status ($p < 0.050$) or living in a metropolitan area ($p = 0.006$) were more likely to have lower overall knowledge of IMD. Participants who were not parents ($p < 0.001$), male gender ($p < 0.001$), single ($p < 0.001$), highly educated ($p = 0.022$) or had high household income ($p = 0.015$), had lower concern about IMD.
Conclusion: Large community knowledge gaps for IMD were observed, particularly amongst adolescents and adults with low educational attainment and low socio-economic status. Improving community knowledge of IMD could help ensure optimal uptake of a new meningococcal vaccine. Our study results can help guide development of community tailored immunisation education programs.

1. Introduction

Invasive meningococcal disease (IMD) is characterised by its rapid onset, high case fatality, high rate of incapacitating long-term sequelae, and is a leading infectious cause of death in childhood in industrialised countries [1]. The highest disease incidence occurs in children < 5 years and adolescents 15–24 years of age [2]. Clinical disease such as meningitis and septicaemia are caused by six of thirteen *Neisseria meningitidis* subgroups (A, B, C, W135, X and Y). Meningococcal vaccines are currently available in Australia to protect against meningococcal serogroups A, C, W135 and Y [3]. However, approximately 85% of serogroup-confirmed meningococcal cases are now caused by serogroup B, as the number of cases of other serogroups, particularly serogroup C, has declined since the implementation of universal meningococcal C childhood vaccination [4,5]. A new meningococcal B (MenB) vaccine, Bexsero®, has recently been approved in the EU and Australia for use in individuals from two months of age. In its meeting in November 2013, the Pharmaceutical Benefits Advisory Committee (PBAC) in Australia did not recommend the inclusion of the multicomponent

Abbreviations: IMD, Invasive meningococcal disease; MenB, Meningococcal B; PBAC, Pharmaceutical Benefits Advisory Committee; SEIFA, Socio Economic Index for Areas.

* Corresponding author at: Vaccinology and Immunology Research Trials Unit (VIRTU), Women's and Children's Hospital, 72 King William Road, North Adelaide, South Australia 5006, Australia. Tel.: +61 8 8161 7708; fax: +61 8 8161 7031.
E-mail addresses: bing.wang@adelaide.edu.au (B. Wang), michelle.clarke@adelaide.edu.au (M. Clarke), hossein.hajialiafzali@adelaide.edu.au (H.H.A. Afzali), helen.marshall@adelaide.edu.au (H. Marshall).

http://dx.doi.org/10.1016/j.vaccine.2014.02.054
0264-410X/

meningococcal B vaccine on the National Immunisation Program Schedule mainly because of its unfavourable cost-effective estimate and uncertain assumptions about vaccine effectiveness and large vaccination coverage required [6]. A resubmission is planned to address issues raised by the PBAC [7].

Awareness and attitudinal research can not only give us in-depth insights into the general public's knowledge about IMD but can also provide useful information to regulatory authorities when considering funding and introduction of a new vaccination program. Such research enables us to understand motivations, barriers, and other influential factors affecting vaccine implementation and also allow us to recognise the needs of different population groups [8]. Finding out public perception of the seriousness of the disease to be prevented by a new vaccine and addressing inaccuracies through targeted education and promotion, are imperative to achieving high coverage of a new vaccine [9], with consequential impact on its cost-effectiveness analysis. Surveys to evaluate the views of stakeholders and target groups are valuable for identifying challenges and opportunities prior to implementing a vaccination program [10]. Previous studies have indicated that public recognition of disease severity could play an important role in parental acceptance of a relevant vaccine [11]. Conversely, lack of disease specific knowledge could lead to poor compliance with new vaccines [12,13]. The assessment of community knowledge and awareness of IMD is required to understand the general public's view of the disease in order to help decision makers and immunisation educators to develop community tailored educational programs targeted to specific groups to maximise vaccine coverage. High uptake of a vaccine with potential herd immunity benefits can affect cost-effectiveness results [14], and hence would be an important consideration in vaccine funding decision-making.

There is currently limited information regarding community, parental and adolescent knowledge and awareness of IMD. An online survey was conducted in seven countries including Australia, to investigate health care providers' and parents' knowledge and attitudes towards vaccine-preventable disease and introduction of new vaccines in infants [15]. The new MenB vaccine was used as an example to detect factors impacting vaccine decisions. It was concluded that improving awareness of the vaccine-preventable disease would be essential for a high vaccine uptake. As an online survey, study results were subject to selection bias with limited generalisability of the study results.

Two other studies in the Netherlands and Auckland have also assessed parental awareness of IMD and suggested that the vast majority of parents were aware of the severity of IMD and that perceived vulnerability was associated with a more positive attitude towards vaccination, however these studies are both limited by selection bias and may not be generalisable to the population [16–18].

This current, large population study aimed to assess knowledge and concern about IMD and perception of disease severity, incidence and susceptibility in the South Australian community and determine factors associated with lower or higher knowledge and concern prior to the introduction of the new MenB vaccine.

2. Methods

This cross-sectional study was conducted by face to face interviews in South Australia. 5200 households were randomly selected according to the collectors' districts used by the Australian Bureau of Statistics in the 2006 Census and stratified by metropolitan or rural location [19]. The person in the household, who most recently celebrated their birthday and was 15 years or older, was interviewed (one interview per household).

General Understanding of invasive meningococcal disease

- What do you understand by the term 'meningococcal disease'? (open-ended question)

Understanding of severity of invasive meningococcal disease

- Which do you believe best describe your understanding of meningococcal disease in terms of severity?
  1. Mild disease
  2. Moderately Severe (may require hospitalisation)
  3. Severe (requires hospitalisation)
  4. Very Severe (may be life threatening or fatal)
  5. Don't know/Unsure

Understanding of incidence of invasive meningococcal disease

- Which do you believe best describe your understanding of meningococcal disease in terms of incidence?
  1. Rare (affects less than 1/1000 people)
  2. Uncommon (affects less than 1/100 people)
  3. Common (affects more than 1/100 people)
  4. Very common (affects more than 1/10 people)
  5. Don't know/Unsure

Understanding of susceptibility to invasive meningococcal disease

- Which do you believe best describe your understanding of meningococcal disease in terms of people affected?
  1. Mostly children
  2. Mostly adolescents
  3. Mostly children or adolescent
  4. Mostly elderly
  5. Mostly people with other medical conditions
  6. Any age equally
  7. Don't know/Unsure

Overall concern about invasive meningococcal disease

- On a scale of 0 – 10 where 0 means you are not concerned at all and 10 means you are extremely concerned, how concerned are you about meningococcal disease?

Enter number 0 – 10 ☐☐ or R for "Refused"

Fig. 1. Interview questions on understanding and concern about invasive meningococcal disease.

Questions were asked to assess general understanding and perception of severity, incidence and susceptibility to IMD, and concerns about IMD (Fig. 1). Detailed demographic details were collected including age, gender, country of birth, marital status, family composition, educational attainment, work status and household income.

Statistical analyses were performed using Stata, version 11 (StataCorp) with the survey data weighted in accordance with 2011 Census figures to provide a demographic description of the South Australian population by age and gender. The weighting process ensured our findings were representative of the South Australian population as a whole. Descriptive results were reported for demographic data. An open ended question was used to gauge the general understanding of IMD in the community.

The outcome measures included an overall score of knowledge of IMD and concern about the disease. Answers to three questions on knowledge of severity, incidence and susceptibility to IMD were dichotomised as "correct" or "incorrect". When the participant chose a correct answer to one question, one score was given to the participant. The overall score was calculated as the total scores of these three questions. Participants who answered at least two of these three questions correctly were considered to have a higher overall score (2–3). An overall score less than two was categorised as a lower overall score (0–1). The participants were asked to assess their concern about IMD on a scale of 0 to 10 with an opt-out option "refused" or "don't know". A level of 6–10 was classified as "higher concern" and a level of 0–5 was classified as "lower concern".

The predictor variables were comprised of country of birth, marital status, educational attainment, work status, household income, gender, age, geographical area, socio-economic status and parental status of the participants (whether the participants were parents or not in the household). The levels of socio-economic status were determined by the Socio Economic Index for Areas (SEIFA) Index of Relative Socioeconomic Disadvantage [20].

Univariate and multiple logistic regression analyses were performed to test association between predictor variables and outcome measures. Any above-mentioned covariates with a p-value $\leq$ 0.20 on a univariate analysis of association with an outcome measure, were included into a multivariate logistic model. All results presented in the univariate and multivariate analyses were weighted. A two-sided p-value of less than 0.05 was deemed to be statistically significant.

The study was approved by the Women's and Children's Health Network Human Research Ethics Committee and the University of Adelaide Human Research Ethics Committee.

3. Results

3.1. Study population

Among 5200 randomly selected households, 137 were not permanent tenants and were excluded. Of the remaining 5063 households, 3055 participants were interviewed with a response rate of 60.3%. 2008 households did not complete interviews due to various reasons (refusal (n = 1178), contact not being established after six attempts (n = 460), mental incapacity (n = 94), non-English speaker (n = 88), other (n = 188)). Interviews were conducted between 4th September and 12th December 2012. Over half the participants were Australian born (74.2%, n = 2267) and 54.6% were employed (n = 1668). Approximately 70% of households (n = 2131) did not contain children and one third of participants (31.8%, n = 972) were parents in the households. 15.9% of participants were adolescents aged 15–24 years (n = 487) (Table 1).

3.2. General understanding of IMD

Almost a quarter of participants (23.5%, n = 717) had no knowledge of IMD and 15.9% (n = 486) understood that IMD was a bacterial infection with almost 10% of participants (n = 278) believing incorrectly that IMD was a viral infection. There was a large variety of answers to the question "What do you understand by the term 'meningococcal disease'?" with the majority of people able to identify some characteristics of IMD. Although IMD is rare, there was evidence of a close association with a case for two participants, one who described that their grandson had died of IMD with another participant indicating they knew a girl who underwent amputation of her arms and legs following IMD. Just over a quarter of participants (30.4%, n = 930) described IMD as "deadly", "serious" or "severe" infection (Table 2).

3.3. Overall knowledge of IMD

In total, 63.4% of participants (n = 1933) answered at least two of three questions on severity, incidence and susceptibility to IMD correctly and were classified as having higher knowledge with 27.1% (n = 827) answering only one question correctly and 9.4% (n = 288) responding to all questions incorrectly.

The majority (87.2%, n = 2661) understood correctly that IMD was a severe or very severe disease. Birth country not Australia (p < 0.001), single status (p = 0.008), having not completed school (p = 0.006), low household income (p < 0.050), male gender (p < 0.001), adolescents (p < 0.050) or metropolitan residential area (p = 0.038), were associated with a lower odds of responding correctly to the question on IMD severity. Most participants (69.6%, n = 2126) were incorrect in their knowledge of the incidence of IMD: 35.2% (n = 1074) answering that IMD was uncommon (incidence rate <1/100), but not rare (incidence rate <1/1000), 19.3% (n = 589) believing that IMD was common (incidence rate >1/100), and 13.4% (n = 409) not able to answer the question and 1.8% (n = 53) considering IMD as "very common" (incidence rate >1/10). Participants who were born outside Australia (p = 0.010), did not complete tertiary education (p < 0.005), had low or medium household income (p < 0.050), were females (p < 0.001), were adolescents (p = 0.020), or had low socio-economic status (p = 0.003) were less likely to answer the question on IMD incidence correctly. More than half (55.3%, n = 1689) gave a correct answer to the question on IMD susceptibility and agreed children and/or adolescents were the main groups affected, with one third (30.4%, n = 929) describing incorrectly that IMD affected any age equally and 12.0% (n = 367) being uncertain of the answer. Male gender (p = 0.004), metropolitan residential area (p = 0.003), and low or medium socio-economic status (p < 0.050) were associated with answering the question on age group susceptibility incorrectly.

After adjusting for socio-demographic covariates, adolescents (p < 0.050), being born outside Australia (p < 0.001), low educational level (p = 0.019), low household income (p = 0.011), metropolitan residential area (p = 0.006) and low/medium socio-economic status (p < 0.050) were associated with a lower overall score of IMD knowledge (Table 3). No difference in levels of overall IMD knowledge was found between parents and non-parents (OR: 1.00 (95% CI: 0.75–1.33), p = 0.996).

Adolescents had lower knowledge of IMD including severity (OR: 0.34 (95% CI: 0.18–0.64), p = 0.001), incidence (OR: 0.56 (95% CI: 0.33–0.94), p = 0.028) and susceptibility to IMD (OR: 0.86 (95% CI: 0.56–1.33), p = 0.493) in comparison with adults aged ≥25 years after adjusting other covariates. In general, adolescents were less likely to gain a higher score of overall IMD knowledge (OR: 0.59 (95% CI: 0.38–0.92), p = 0.020).

3.4. General concern about IMD

1922 participants (62.9%) had lower concern (a score of 0–5) about IMD including 19.1% (n = 585) who scored concern as zero. 965 participants (31.6%) expressed higher concern (a score of 6–10) about the disease consisting of 9.8% (n = 301) being extremely concerned (a score of 10), with 105 (3.4%) refusing and 63 (2.1%) stating "don't know". Participants who were not parents (p < 0.001), male gender (p < 0.001), single (p < 0.001), highly educated (p = 0.022) or had high household income (p = 0.015), were more likely to have lower concern about the disease (Table 4). In addition, the level of concern about IMD was not significantly associated with overall knowledge scores (p = 0.171).

4. Discussion

Our study results revealed sub-optimal understanding and large knowledge gaps of IMD, particularly amongst adolescents. Although around 60% of participants responded correctly to at least two of three questions on severity, incidence and susceptibility to IMD, a considerable number of participants were not aware of IMD or had misconceptions about the disease. Despite the seriousness of meningococcal disease, more than half of participants had lower concern about IMD. Our study identified a number of socio-demographic factors that were related to lower knowledge of IMD and lower concern about the disease which have previously been associated with low knowledge of vaccine preventable diseases [21,22].

Participants with a low level of educational attainment, household income or socio-economic status were more likely to have lower overall knowledge of IMD compared with those who had

Table 1
Socio-demographic characteristics.

Variables	Number	Weighted number[a]	Weighted percent[a]	95% confidence interval
Age				
15–24 (adolescents)	306	487	15.9	14.2–17.7
25–54 (young and middle aged adults)	1389	1501	49.1	47.1–51.2
55+ (older adults)	1360	1066	34.9	33.1–36.7
Gender				
Male	1279	1494	48.9	46.9–50.9
Female	1776	1561	51.1	49.1–53.1
Country of birth				
Non-Australia	792	787	25.8	24.0–27.5
Australia	2262	2267	74.2	72.5–76.0
Marital Status				
Married/De Facto	1719	1905	62.4	60.5–64.4
Single	1333	1147	37.6	35.6–39.5
Educational attainment				
Lower than Year 12 education	1113	1063	34.8	32.9–36.7
Higher than or equal to Year 12 education/trade/certificate/diploma	1281	1307	42.8	40.9–44.8
Degree or higher	655	682	22.3	20.7–24.0
Work status				
Employed	1561	1668	54.6	52.6–56.6
Unemployed	288	300	9.8	8.6–11.0
Retired	850	614	20.1	18.7–21.5
Student	192	330	10.8	9.3–12.3
Other	163	144	4.7	3.9–5.5
Household income				
Low (≤ AUD $40,000)	820	583	27.7	25.8–29.6
Medium (AUD $40,001–$80,000)	603	582	27.6	25.6–29.7
High (≥ AUD $80,001)	821	941	44.7	42.3–47.0
Area				
Metropolitan	2241	2235	73.2	71.4–75.0
Rural	814	820	26.8	25.0–28.6
Socio-economic status				
Low (1st–33rd percentile)	1144	1160	38.0	36.0–39.9
Medium (34th–66th percentile)	938	907	29.7	27.9–31.5
High (67th–100th percentile)	973	988	32.3	30.5–34.2
Total number of children in household				
0	2131	2131	69.8	68.1–71.4
1	346	346	11.3	10.2–12.5
2	397	397	13.0	11.8–14.2
3+	180	180	5.9	5.1–6.7
Total number of people in household				
1	759	759	24.8	23.33–26.4
2	1138	1138	37.3	35.5–39.0
3	432	432	14.1	12.9–15.4
4	477	477	15.6	14.3–16.9
5+	249	249	8.2	7.2–9.1
Participant's parental status				
No	2220	2080	68.2	66.2–70.1
Yes	834	972	31.8	29.9–33.8

[a] All results were weighted by the inverse of the individual's probability of selection and the response rate in metropolitan and country regions, and then re-weighted to benchmarks derived from the 2011 Estimated Residential Population based on 2011 Population Census.

Table 2
Descriptive results of general understanding of invasive meningococcal disease.

General understanding of IMD	Number	Weighted number[a]	Weighted percent[a]	95% confidence interval
Don't know	654	717	23.5	21.7–25.3
Bacterial infection that can be deadly	490	486	15.9	14.5–17.4
Meningitis–inflammation in the tissue	447	419	13.7	12.4–15.1
Virus/viral infection	286	278	9.1	8.0–10.3
Rash/spots/fever	270	260	8.5	7.4–9.6
Life threatening/deadly	223	212	6.9	6.0–7.9
Others	157	165	5.4	4.5–6.3
Serious/dangerous/severe	118	119	3.9	3.2–4.7
Severe infection resulting in amputation	110	113	3.7	2.9–4.4
Flesh eating infection	105	103	3.4	2.7–4.1
Brain disease/affects brain	54	51	1.7	1.2–2.2
Waterborne infection	31	27	0.9	0.5–1.2
Affects young people	30	29	0.9	0.6–1.3
Blood disease/affects blood	27	25	0.8	0.5–1.2
Flu like illness	20	20	0.7	0.3–1.0
An infection	15	13	0.4	0.2–0.7
Contagious	15	14	0.5	0.2–0.7

[a] All results were weighted by the inverse of the individual's probability of selection and the response rate in metropolitan and country regions, and then re-weighted to benchmarks derived from the 2011 Estimated Residential Population based on 2011 Population Census.

Table 3
Predictors of participants with a higher overall knowledge score of invasive meningococcal disease[a]

Variables	Participants with a higher overall score (2–3)[b]		Participants with a lower overall score (0–1)[b]		Univariate associations			Multivariate logistic regression analysis		
	n	%	*n*	%	Odds ratio	95% confidence interval	*p*-Value	Adjusted odds ratio	95% confidence interval	*p*-Value
Age							<0.001			0.067
15–24 (adolescents)	219	45.1	266	54.9	1.00	–		–	–	–
25–54 (young and middle aged adults)	1019	68.0	480	32.0	2.59	1.97–3.40	<0.001	1.68	1.07–2.64	0.023
55+ (older adults)	695	65.4	368	34.6	2.30	1.75–3.02	<0.001	1.69	1.03–2.77	0.038
Gender										
Male	937	62.9	553	37.1	1.00	–		–	–	–
Female	996	64.0	561	36.0	1.05	0.88–1.24	0.586	–	–	–
Country of birth										
Non-Australia	420	53.5	366	46.5	1.00	–		–	–	
Australia	1152	66.9	749	33.1	1.76	1.46–2.12	<0.001	1.55	1.23–1.98	<0.001
Marital Status										
Married/De Facto	1289	67.8	612	32.2	1.00	–		–	–	
Single	643	56.2	501	43.8	0.61	0.51–0.72	<0.001	0.99	0.79–1.25	0.939
Educational attainment							<0.001			0.055
Lower than Year 12 education	601	56.7	459	43.3	1.00	–		–	–	
Higher than or equal to Year 12 education/trade/certificate/diploma	842	64.6	461	35.4	1.39	1.15–1.69	0.001	1.22	0.96–1.56	0.099
Degree or higher	489	71.8	192	28.2	1.95	1.53–2.48	<0.001	1.47	1.06–2.02	0.019
Work status							<0.001			0.660
Employed	1232	68.0	532	32.0	1.00	–		–	–	
Unemployed	179	59.8	120	40.2	0.70	0.52–0.94	0.016	0.93	0.64–1.35	0.709
Retired	388	63.3	225	36.7	0.81	0.67–0.98	0.033	1.16	0.81–1.64	0.418
Student	150	45.6	179	54.4	0.39	0.28–0.55	<0.001	0.81	0.45–1.45	0.474
Other	84	59.2	58	40.8	0.68	0.47–0.99	0.044	0.85	0.53–1.35	0.482
Household income							<0.001			0.039
Low (≤ AUD $40,000)	365	62.9	215	37.1	1.00	–		–	–	
Medium (AUD $40,001–$80,000)	398	68.4	184	31.6	1.28	0.99–1.64	0.056	1.25	0.93–1.67	0.135
High (≥ AUD $80,001)	699	74.5	239	25.5	1.72	1.36–2.18	<0.001	1.53	1.10–2.14	0.011
Area										
Metropolitan	1394	62.6	835	37.4	1.00	–		–	–	
Rural	539	65.8	280	34.2	1.15	0.95–1.40	0.155	1.44	1.11–1.87	0.006
Socio-economic status							0.001			0.006
Low (1st–33rd percentile)	692	59.8	465	40.2	1.00	–		–	–	
Medium (34th–66th percentile)	564	62.4	341	37.6	1.11	0.91–1.36	0.303	1.06	0.82–1.36	0.672
High (67th–100th percentile)	676	68.7	309	31.3	1.47	1.20–1.81	<0.001	1.54	1.16–2.05	0.003
Participant's parental status										
No	1293	62.3	782	37.7	1.00	–		–	–	–
Yes	637	65.7	333	34.3	1.16	0.96–1.40	0.130	1.00	0.75–1.33	0.996

[a] All results were weighted by the inverse of the individual's probability of selection and the response rate in metropolitan and country regions, and then re-weighted to benchmarks derived from the 2011 Estimated Residential Population based on 2011 Population Census.

[b] Three questions on knowledge of severity, incidence and susceptibility to IMD were used to assess the overall knowledge of meningococcal disease for each participant. Participants who answered at least two of these three questions correctly, had a higher overall score (2–3). An overall score less than two was categorised as a lower overall score (0–1).

Table 4
Predictors of participants with higher concern of invasive meningococcal disease[a]

Variables	Participants with higher concern[b] (6–10)		Participants with lower concern[b] (0–5)		Univariate associations			Multivariate Logistic Regression Analysis		
	n	%	*n*	%	Odds ratio	95% confidence interval	*p*-Value	Adjusted odds ratio	95% confidence interval	*p*-Value
Age							0.001			0.257
15–24 (adolescents)	104	23.5	340	76.5	1.00	–		–	–	
25–54 (young and middle aged adults)	506	35.3	927	64.7	1.78	1.29–2.45	<0.001	1.25	0.75–2.08	0.400
55+ (older adults)	355	35.1	656	64.9	1.76	1.28–2.43	0.001	1.52	0.88–2.64	0.135
Gender										
Male	374	26.7	1204	73.3	1.00	–		–	–	
Female	591	39.7	898	60.3	1.80	1.51–2.16	<0.001	1.75	1.41–2.17	<0.001
Country of birth										
Non-Australia	213	31.0	475	69.0	1.00	–		–	–	
Australia	752	34.2	1447	65.8	1.16	0.94–1.42	0.159	1.04	0.82–1.33	0.740
Marital Status										
Married/De Facto	696	38.1	1130	61.9	1.00	–		–	–	
Single	268	25.3	791	74.7	0.55	0.46–0.66	<0.001	0.62	0.49–0.79	<0.001
Educational attainment							<0.001			0.065
Lower than Year 12 education	378	37.9	619	62.1	1.00	–		–	–	
Higher than or equal to Year 12 education/trade/certificate/diploma	414	33.1	838	66.9	0.81	0.67–0.98	0.031	0.90	0.70–1.15	0.410
Degree or higher	172	27.0	465	73.0	0.61	0.47–0.77	<0.001	0.69	0.50–0.95	0.022
Work status							<0.001			0.965
Employed	532	33.3	1064	66.7	1.00	–		–	–	
Unemployed	122	43.5	159	56.5	1.54	1.15–2.05	0.003	0.98	0.67–1.42	0.901
Retired	199	34.8	373	65.2	1.07	0.87–1.30	0.525	0.94	0.67–1.31	0.712
Student	57	19.3	239	80.7	0.48	0.31–0.74	0.001	0.87	0.41–1.85	0.722
Other	54	38.5	87	61.5	1.25	0.86–1.83	0.247	1.11	0.68–1.81	0.666
Household income							0.008			0.051
Low (≤ AUD $40,000)	221	39.9	333	60.1	1.00	–		–	–	
Medium (AUD $40,001–$80,000)	206	36.6	357	63.4	0.87	0.68–1.11	0.257	0.79	0.59–1.05	0.110
High (≥ AUD $80,001)	290	31.7	626	68.3	0.70	0.55–0.88	0.002	0.65	0.47–0.92	0.015
Area										
Metropolitan	651	31.0	1451	69.0	1.00	–		–	–	
Rural	314	40.0	471	60.0	1.48	1.22–1.80	<0.001	1.23	0.95–1.59	0.122
Socio-economic status							<0.001			0.325
Low (1st–33rd percentile)	416	38.4	665	61.6	1.00	–		–	–	
Medium (34th–66th percentile)	275	31.9	589	68.1	0.75	0.61–0.92	0.007	0.85	0.66–1.09	0.204
High (67th–100th percentile)	274	29.1	668	70.9	0.66	0.53–0.81	<0.001	0.82	0.62–1.10	0.191
Participant's parental status										
No	563	28.9	1387	71.1	1.00	–		–	–	
Yes	402	43.0	532	57.0	1.86	1.54–2.24	<0.001	2.09	1.58–2.78	<0.001

[a] All results were weighted by the inverse of the individual's probability of selection and the response rate in metropolitan and country regions, and then re-weighted to benchmarks derived from the 2011 Estimated Residential Population based on 2011 Population Census.
[b] The concern about invasive meningococcal disease was assessed on a scale of 0 to 10. A level of 6–10 was classified as "higher concern" and a level of 0–5 was classified as "lower concern".

high educational attainment, household income or socio-economic status. Moreover, adolescents had lower knowledge of IMD in comparison with non-adolescents. As adolescents are a target group for MenB vaccination, increasing awareness and knowledge of IMD is a priority. In addition, it is important that the information is relevant to what adolescents want to and need to know and in a format that is applicable to help them make an informed decision about immunisations such as MenB.

In our study, parental status of participants was significantly associated with higher concern about IMD. A study in the Netherlands indicated parents overestimated the risk of being infected with the meningococcus and dying from IMD. This study showed that highly educated parents were less worried and had lower perceived risk of IMD infection which is consistent with our findings [17]. Female participants were almost twice as likely to have higher concern about IMD than males. A similar gender association was found in web-based and community surveys about influenza showing female parents perceived a higher threat of influenza than males [21,23].

Although a high level of educational attainment or household income was significantly associated with lower concern and higher scores of overall knowledge of IMD, the lower concern and a higher level of knowledge of IMD were not related, indicating that increasing accurate disease specific knowledge may not influence concern. Previous survey studies support the finding that greater knowledge of disease is not associated with levels of anxiety or concern [24,25].

Previous research has indicated health education and improvement in public awareness of vaccine-preventable disease (e.g. IMD) could increase uptake of a new vaccine [15,22]. A survey of influenza vaccines showed that lack of disease related knowledge and a lower perceived risk from infections could lead to vaccine declination [26]. A questionnaire survey in the UK and online survey study in the US revealed knowledge of the disease, particularly severity and susceptibility, affected parental acceptance of a new vaccine [23,27]. Our study results provide community-specific information on general awareness, knowledge of severity, incidence and susceptibility, and overall concern about IMD, which can enable policy makers and immunisation educators to develop community-tailored and appropriate educational programs once a new MenB vaccine is available. For example, participants born outside Australia were associated with a low level of IMD knowledge in our study. Information about IMD should be provided in a variety of languages to assist migrants who may originate from countries with lower incidence of IMD. Our findings can assist in increasing awareness of the severity of IMD and correcting any misconceptions effectively by targeting simple but specific information to address these inaccuracies. For example, around 10% of participants confused IMD with a viral infection or flu, when in fact, it is a bacterial infection associated with poorer prognosis and higher case fatality rates than influenza, a most common viral infection. Furthermore, understanding of community knowledge of the disease could be helpful for health care providers to target specific groups with less knowledge to efficiently improve uptake of a new vaccine and empower individuals to make more informed decisions around vaccination. Vaccination coverage rates affect economic evaluations of vaccines [28] and high uptake of a vaccine with potential indirect population protection could add extra benefits to a vaccination program [14]. Engaging the community to improve public awareness of IMD and prevention by vaccination can identify the appropriate information and optimal delivery of that information. Awareness and attitudinal research is required, particularly involving adolescents, the highest at risk group with the lowest knowledge and concern and the group most likely to be targeted for a future MenB immunisation program.

Our study had several important strengths. Firstly, a large number of participants were randomly selected from the South Australian population and the survey data were weighted to report on the population level improving generalisability of our findings. In addition, we were able to assess adolescent's knowledge of meningococcal disease, an important target group for MenB immunisation. Furthermore, in-depth socio-demographic data were collected which were essential to investigate which socio-demographic groups had low knowledge and awareness of IMD. Lastly, as the survey was conducted through face to face interviews, it may be easier for interviewers and participants to either clarify answers or questions so results are more likely to be an accurate representation of knowledge than other forms of interviews. However, there is the potential that social desirability responses in a face to face interview may bias the results. This was a cross sectional study and therefore has some additional limitations as the study was conducted at one point in time. The survey was conducted in 2012 prior to licensing of the MenB vaccine. News and new promotional programs may raise public awareness of the disease once the vaccine is available for private purchase. Forty percent of households approached did not participate in the survey. Since no socio-demographic information was obtained from the non-responders, there may be a nonresponse bias that was unable to be assessed in our study. Non-English speakers were not included in the study. Nonetheless, the proportion of non-English speakers excluded from the study was small, so is likely to have limited impact on the study results. The interviews were conducted in South Australia, and although results were generalisable to the population of South Australia, they may not be generalisable to the Australian population as a whole.

As serogroup B IMD predominates in Australia, accounting for around 85% of 241 laboratory-confirmed IMD cases in 2011 [5], high uptake of the new MenB vaccine would be required to reduce the incidence of IMD and relieve the economic burden of the disease. The delivery of community tailored educational programs and informational materials can help to achieve high coverage by targeting those with the least knowledge and lowest concern about IMD once a MenB vaccine is available. If Bexsero® is not funded on the National Immunisation Program but available only on the private market, community perceptions and understanding will be key to optimising vaccine uptake and protection for the community.

Acknowledgements

We would like to thank Mr Thomas Sullivan for his assistance in data analyses. Associate Professor Helen Marshall acknowledges support from the National Health and Medical Research Council of Australia: Career Development Fellowship (1016272).

Conflict of interests: Associate Professor Helen Marshall has been a member of vaccine advisory boards for GlaxoSmithKline Biologicals and Wyeth, and has received travel support from CSL, Pfizer, Novartis, and GlaxoSmithKline Biologicals to present scientific data at international meetings. Her institution has received funding for investigator-led research from GlaxoSmithKline, Sanofi-Pasteur, and Novartis Vaccines. Ms Michelle Clarke has received a travel support grant from GlaxoSmithKline to present independent research at a national conference. There are no other conflicts of interest to declare. *Funding:* Faculty of Health Sciences New Appointment Funding for 2012–2013, University of Adelaide, South Australia provided independent funding for this study. Funding for the data collection was partly supported by a grant from Novartis Vaccines and Diagnostics Pty Ltd to the Women's and Children's Hospital. The Vaccinology and Immunology Research Trials Unit (VIRTU) is the research organisation that conducted the analyses of the data. This was an investigator led study, designed and conducted independently of the sponsors with the analyses and writing of the publication completed by the listed authors. *Contribution:*

BW performed the data analyses and prepared the first draft of the manuscript under direct supervision of HM and HA. HA contributed to and reviewed and edited the manuscript. HM assisted in study design and contributed to and reviewed the manuscript. MC assisted in study design and reviewed and edited the manuscript. We confirm that the manuscript has been read and approved by all named authors and that there are no other persons who satisfied the criteria for authorship but are not listed. We further confirm that the order of authors listed in the manuscript has been approved by all authors.

References

[1] Hart CA, Thomson AP. Meningococcal disease and its management in children. BMJ (Clinical Research Ed) 2006;333(7570):685–90.
[2] Chiu C, Dey A, Wang H, Menzies R, Deeks S, Mahajan D, et al. Vaccine preventable diseases and vaccination coverage in Australia, 2005 to 2007. Commun Dis Intell 2010;34(Supplement):S50–6.
[3] The Australian Immunisation Handbook, 10th edition 2013. Department of Health and Aging, Australia.
[4] Annual report of the Australian Meningococcal Surveillance Programme, 2001. Commun Dis Intell Q Rep. 2002;26(3):407-18.
[5] Lahra MM, Enriquez RP. Annual report of the Australian Meningococcal Surveillance Programme, 2011. Commun Dis Intell Q Rep 2012;36(3):E251–62.
[6] November 2013 PBAC Outcomes - 1st Time Decisions Not to Recommend, Pharmaceutical Benefits Advisory Committee (PBAC), The Department of Health, Commenwealth of Australia, viewed 31 Jan 2014, http://www.pbs.gov.au/info/industry/listing/elements/pbac-meetings/pbac-outcomes/2013-11
[7] Patients want compassion on meningococcal vaccine, PharmaDispatch, viewed 31 Jan 2014, http://www.pharmadispatch.com/patients-want-compassion-on-meningococcal-vaccin/
[8] Snape MD, Medini D, Halperin SA, DeTora L, Drori J, Moxon ER. The challenge of post-implementation surveillance for novel meningococcal vaccines. Vaccine 2012;30(30 Suppl 2):B67–72.
[9] Noakes K, Yarwood J, Salisbury D. Parental response to the introduction of a vaccine against human papilloma virus. Hum Vaccin 2006;2(6):243–8.
[10] Ortiz JR, Neuzil KM, Ahonkhai VI, Gellin BG, Salisbury DM, Read JS, et al. Translating vaccine policy into action: a report from the Bill & Melinda Gates Foundation Consultation on the prevention of maternal and early infant influenza in resource-limited settings. Vaccine 2012;30(50):7134–40.
[11] Yarwood J, Noakes K, Kennedy D, Campbell H, Salisbury D. Tracking mothers attitudes to childhood immunisation 1991-2001. Vaccine 2005;23(48–49):5670–87.
[12] Dorell C, Yankey D, Strasser S. Parent-reported reasons for nonreceipt of recommended adolescent vaccinations, national immunization survey: teen, 2009. Clin Pediatr (Phila) 2011;50(12):1116–24.
[13] Hak E, Schonbeck Y, De Melker H, Van Essen GA, Sanders EA. Negative attitude of highly educated parents and health care workers towards future vaccinations in the Dutch childhood vaccination program. Vaccine 2005;23(24):3103–7.
[14] Christensen H, Hickman M, Edmunds WJ, Trotter CL. Introducing vaccination against serogroup B meningococcal disease: an economic and mathematical modelling study of potential impact. Vaccine 2013;31(23):2638–46.
[15] Bakhache P, Rodrigo C, Davie S, Ahuja A, Sudovar B, Crudup T, et al. Health care providers' and parents' attitudes toward administration of new infant vaccines – a multinational survey. Eur J Pediatr 2013;172(4):485–92.
[16] Petousis-Harris H, Turner N, Soe B. Parent views on school based immunisation: a survey of parents of year 1 and 6 in three diverse Auckland schools. N Z Fam Physician 2004;31(4):222–8.
[17] Timmermans DR, Henneman L, Hirasing RA, van der Wal G. Attitudes and risk perception of parents of different ethnic backgrounds regarding meningococcal C vaccination. Vaccine 2005;23(25):3329–35.
[18] Timmermans DR, Henneman L, Hirasing RA, van der Wal G. Parents' perceived vulnerability and perceived control in preventing Meningococcal C infection: a large-scale interview study about vaccination. BMC Public Health 2008;8:45.
[19] Health Omnibus Survey Methodology Brief Report 2012. Population Research and Outcomes Studies Unit, The University of Adelaide.
[20] Pink B. Information paper: an introduction to socio-economic indexes for areas (SEIFA), 2006. Canberra: Australian Bureau of Statistics (ABS); 2008.
[21] Marshall H, Tooher R, Collins J, Mensah F, Braunack-Mayer A, Street J, et al. Awareness, anxiety, compliance: community perceptions and response to the threat and reality of an influenza pandemic. Am J Infect Control 2012;40(3):270–2.
[22] Marshall H, Ryan P, Roberton D, Baghurst P. A cross-sectional survey to assess community attitudes to introduction of Human papillomavirus vaccine. Aust N Z J Public Health 2007;31(3):235–42.
[23] Flood EM, Rousculp MD, Ryan KJ, Beusterien KM, Divino VM, Toback SL, et al. Parents' decision-making regarding vaccinating their children against influenza: a web-based survey. Prev Med (Baltim) 2010;32(8):1448–67.
[24] Goodman E, Cohall AT. Acquired immunodeficiency syndrome and adolescents: knowledge, attitudes, beliefs, and behaviors in a New York City adolescent minority population. Pediatrics 1989;84(1):36–42.
[25] Robb KA, Miles A, Campbell J, Evans P, Wardle J. Can cancer risk information raise awareness without increasing anxiety? A randomized trial. Prev Med 2006;43(3):187–90.
[26] Eppes C, Wu A, You W, Cameron KA, Garcia P, Grobman W. Barriers to influenza vaccination among pregnant women. Vaccine 2013;31(27):2874–8.
[27] Bedford H, Lansley M. More vaccines for children? Parents' views. Vaccine 2007;25(45):7818–23.
[28] Pitman RJ, Nagy LD, Sculpher MJ. Cost-effectiveness of childhood influenza vaccination in England and Wales: results from a dynamic transmission model. Vaccine 2013;31(6):927–42.