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ORIGINAL ARTICLE

Declining Public Awareness of Heart Attack Warning Symptoms in the Years Following an Australian Public Awareness Campaign: A Cross-Sectional Study

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Background The National Heart Foundation of Australia's (NHFA) *Warning Signs* campaign ran between 2010 and 2013. This study examines trends in Australian adults' ability to name heart attack symptoms during the campaign and in the years following.

Methods Using the NHFA's HeartWatch data (quarterly online surveys) for adults aged 30–59 years, we conducted an adjusted piecewise regression analysis comparing trends in the ability to name symptoms during the campaign period plus one year lag (2010–2014) to the post-campaign period (2015–2020)

Results Over the study period, there were 101,936 Australian adults surveyed. Symptom awareness was high or increased during the campaign period. However, there was a significant downward trend in each year following the campaign period for most symptoms (e.g., chest pain: adjusted odds ratio [AOR] =0.91, 95% CI: 0.56–0.80; arm pain: AOR=0.92, 95%CI: 0.90–0.94). Conversely, the inability to name any heart attack symptom increased in each year following the campaign (3.7% in 2010 to 19.9% in 2020; AOR=1.13, 95%CI: 1.10–1.15); these respondents were more likely to be younger, male, have less than 12 years of education, identify as Aboriginal and/or Torres Strait Islander Peoples, speak a language other than English at home and have no cardiovascular risk factors.

Conclusion Awareness of heart attack symptoms has decreased in the years since the *Warning Signs* campaign in Australia, with 1 in 5 adults currently unable to name a single heart attack symptom. New approaches are needed to promote and sustain this knowledge, and to ensure people act appropriately and promptly if symptoms occur.

Keywords Acute coronary syndrome • Campaigns • Education • Surveys

Mass media health campaigns are widely used to expose large proportions of populations to messages about health and to promote behaviour change. There is now a large body of evidence demonstrating that these campaigns can be an

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effective means of changing population-based knowledge and beliefs, but a more varied response appears to be seen with behaviour change [1]. Common elements of successful campaigns include sufficient funding to provide frequent exposure over time, adequate access to promoted services, knowing how to reach the target audience, appropriate and sensitive messaging, and addressing known barriers to behaviour change [1].

In the 2000s international evidence showed that many patients experiencing heart attack symptoms were not eligible for time-sensitive critical treatments as they were presenting to hospital too late, or were dying at home [2,3]. Major barriers included not recognising symptoms as heart-related or as serious, not wanting to cause a fuss or trouble others, and seeking medical attention from their local doctor [2]. Following a review of international literature, the National Heart Foundation of Australia (NHFA) recognised the need to educate the Australian public about heart attack symptoms and the appropriate behaviour to act fast and call an ambulance (i.e., emergency medical services [EMS]). In 2009, the NHFA employed an advertising agency to develop and pilot the *Warning Signs* campaign, which then ran across Australian mass media between 2010 and 2013. This AUD$16 million national strategy included mass media education on typical, less common and associated symptoms of acute coronary syndrome (ACS). The campaign also addressed the known barriers to prehospital delay and calling EMS [2] and specifically targeted middle-aged adults.

While active, the campaign had excellent reach [4] and was associated with improvements in ACS treatment-seeking behaviour [4,5] and a reduction in the incidence of out-of-hospital cardiac arrest [6]. However, these evaluations also suggested a waning effect following the campaign, and the long-term impacts of this campaign on symptom awareness have not been reported. A recent review [7] reported no studies that examined the long-term impacts of similar international heart attack campaigns beyond three years, and subgroups (e.g., those with known risk factors) were rarely examined.

Over the campaign period and in the years following the campaign to September 2020, the NHFA tracked the awareness of ACS symptoms in middle-aged Australian adults (aged 30–59 years) through online quarterly surveys, known as the HeartWatch Data. The aim of this study was to examine the long-term impact of the *Warning Signs* campaign on the awareness of ACS symptoms in Australian adults. We also aimed to examine the impact on predetermined subgroups, such as those with cardiovascular risk factors (e.g., history of heart disease or hypertension). Such information is vital to informing policy and practice regarding public education.

Methods

We conducted a retrospective cross-sectional study of the HeartWatch survey data, which was prospectively collected quarterly on Australian adults, aged 30 to 59 years, between 2010 and 2020. This study was approved by the Monash University Ethics Committee (2020-26102-48329).

The Warning Signs Campaign

The *Warning Signs* campaign was a multi-media campaign that ran between 2010 and 2013 across Australian television, radio, digital and print (newspapers and magazines) media and in movie cinemas. The campaign was piloted in three regions (Melbourne, Geelong and Broken Hill) in late 2009, and then ran intermittently across the country between February 2010 and September 2011 and for all of 2013. A funded national campaign on non-subscription television channels and radio occurred between October 2011 and December 2012, and this was active for one month in every 2–3 months. The symptoms described varied across the types of media used, with the major television campaign describing chest tightness, jaw pain and shortness of breath. All media (television advertisements and radio announcements, billboards, and newspaper advertisements) included a web address to learn the warning signs. The main feature of the campaign were two television advertisements targeted at Australian adults aged over 45 years. The first advert showed a deceased white male describing his heart attack symptoms and the actions he should have taken (e.g., calling an ambulance) and the second advertisement showed a cardiologist addressing the known barriers to reacting early to symptoms (e.g., downplaying or denying symptoms) and calling an ambulance (e.g., embarrassment).

Participants and Survey

Respondents were Australian adults participating in market research surveys. The surveys were conducted online every four months by three independent market research companies. Selection of survey respondents was based on age, sex and regions (state/territory) quotas to reflect the demographics and locations of the Australian population. The companies used non-probability online panels recruited through opt-in methods with small funding compensation (AUD$2 to AUD$3).

For this study, we chose to examine the subgroup of adults aged between 30 and 59 years, as this age group included the target audience of the *Warning Signs* campaign and were surveyed in every quarter of the study period.

Data Collection and Variables

We obtained de-identified HeartWatch data for the study period. Data collected included demographics, self-reported cardiovascular medical history and risk factors, and unprompted awareness of heart attack warning signs (Supplementary materials). The market research company categorised responses to the open-ended symptom question into symptoms (based on NHFA input) or a "none" category if no symptoms were given.

Table 1 **Demographics and self-reported risk factors of those surveyed overall and comparison by campaign period.**

Demographics	Overall N (%)	Campaign Period + 1 Year Lag 2010–2014 N (%)	Post-Campaign Period 2015–2020 N (%)	P-value
Age groups				<0.001
30–34	15,347 (15.1)	7,726 (14.3)	**7,621 (15.9)**	
35–39	15,393 (15.1)	7,898 (14.6)	**7,495 (15.6)**	
40–44	16,762 (16.4)	**9,270 (17.1)**	7,492 (15.6)	
45–49	17,405 (17.1)	**9,446 (17.5)**	7,959 (16.6)	
50–54	17,664 (17.3)	**9,583 (17.7)**	8,081 (16.9)	
55–59	19,365 (19.0)	10,128 (18.7)	9,237 (19.3)	
Sex				<0.001
Female	53,959 (52.9)	27,984 (51.8)	**25,975 (54.2)**	
Male	47,977 (47.1)	**26,067 (48.2)**	21,910 (45.8)	
Region				<0.001
New South Wales	17,447 (17.1)	8,492 (15.7)	**8,955 (18.7)**	
Victoria	17,300 (17.0)	8,540 (15.8)	**8,760 (18.3)**	
Queensland	15,640 (15.3)	8,391 (15.5)	7,249 (15.1)	
South Australia	12,792 (12.5)	**6,949 (12.9)**	5,843 (12.2)	
Western Australia	13,839 (13.6)	7,117 (13.2)	**6,722 (14.0)**	
Northern Territory	7,315 (7.2)	**4,176 (7.7)**	3,139 (6.6)	
Tasmania	9,073 (8.9)	**5,323 (9.8)**	3,750 (7.8)	
Australian Capital Territory	8,530 (8.4)	**5,063 (9.4)**	3,467 (7.2)	
Aboriginal and/or Torres Strait Islander				<0.001
Yes	2,095 (2.1)	790 (1.5)	**1,305 (2.7)**	
No	99,841 (97.9)	**53,261 (98.5)**	46,580 (97.3)	
Language other than English at home				<0.001
Yes	15,327 (15.0)	6,854 (12.7)	**8,473 (17.7)**	
No	86,609 (85.0)	**47,197 (87.3)**	39,412 (82.3)	
Highest level of education				<0.001
<12 years	31,579 (31.0)	**18,940 (35.0)**	12,639 (26.4)	
Vocational/TAFE	35,517 (34.8)	**19,318 (35.7)**	16,199 (33.8)	
University	34,840 (34.2)	15,793 (29.2)	**19,047 (39.8)**	
Self-reported cardiovascular risk factors				
Hypertension	33,208 (32.6)	**19,176 (35.5)**	14,032 (29.3)	<0.001
Hypercholesteraemia	33,724 (33.1)	**19,577 (36.3)**	14,147 (29.5)	<0.001
Diabetes	9,852 (9.7)	**5,473 (10.1)**	4,379 (9.1)	<0.001
Heart disease	5,055 (5.0)	**2,855 (5.3)**	2,200 (4.6)	<0.001

Bold highlighted cells represent cells where the observed count is significantly higher than the expected count.
Abbreviation: TAFE, Technical and Further Education.

Statistical Analysis

Baseline characteristics are summarised as counts and percentages with stratification by campaign period. Differences in baseline characteristics across the two periods were assessed using Pearson's chi-squared test. Pearson's standardised residuals were used to identify table cells where the observed counts were significantly higher than would be expected under the null hypothesis of independence. While this does not provide direct head-to-head comparisons between the proportions of two (or more) cells, it has been offered as a proxy *post hoc* test [8]. A standardised residual greater than 2 is determined to be significant.

Trends over the study period were assessed for the main symptoms of interest (chest pain, arm pain) and the inability to name a symptom using piecewise logistic regression models [9]. This is a form of regression that allows separate linear models to be fitted to the data for different ranges of x (the independent variable) in a single model. Knots (or breakpoints) are the values of x where the slope of the linear function changes and separate regression lines are estimated for data on each side of the knot. In our study, yearly quarter represents the independent (x) variable and a knot was set *a priori* at the first quarter of 2015. This provides separate regression lines for the campaign period plus a one-year lag (Jan 2010–Dec 2014) and for the

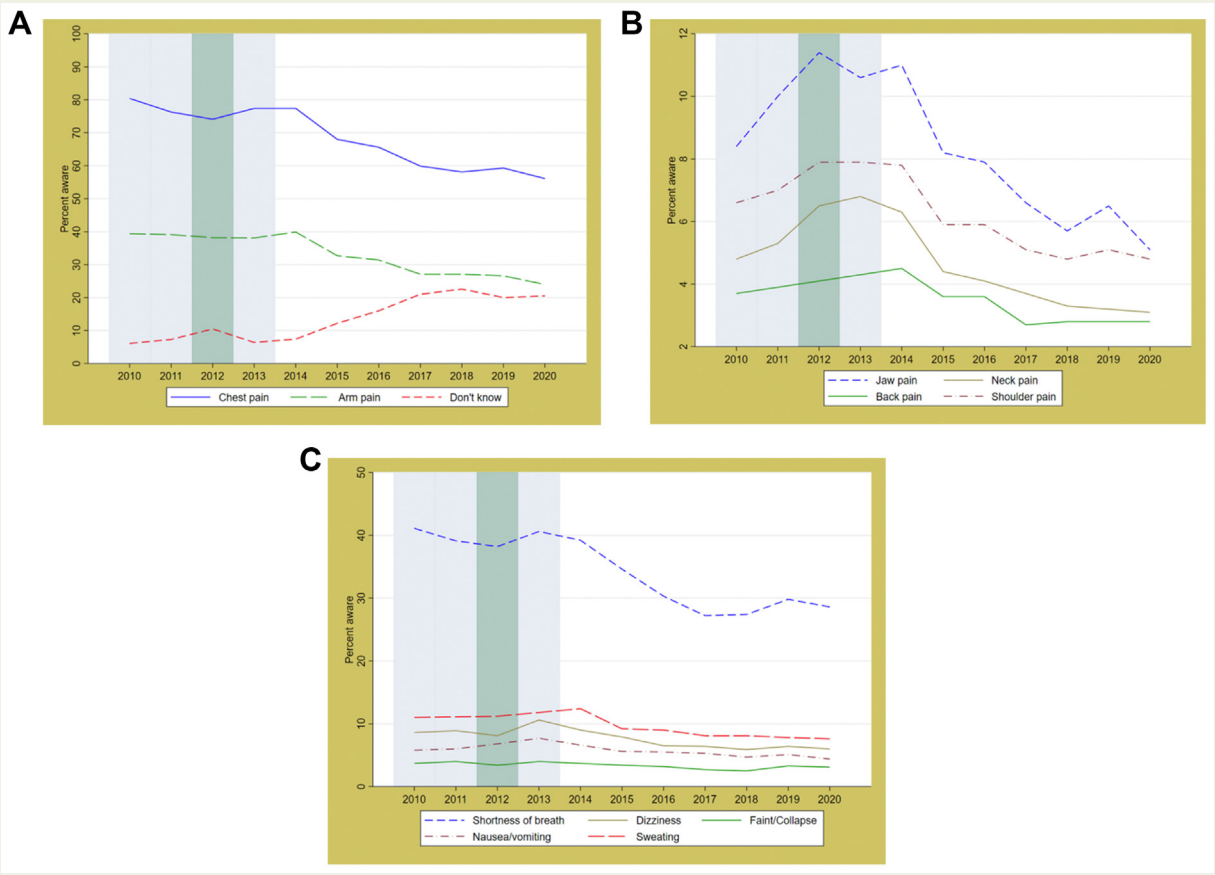

Figure 1 Annual trends in the proportion of Australian adult HeartWatch respondents' ability to name (A) typical or no symptoms, (B) other regions of pain and (C) associated heart attack symptoms (shaded years are periods when the campaign was active, dark green is the paid national campaign).

post-campaign period (Jan 2015–Sep 2020). A one-year lag period was selected based on previous short-term evaluations of the *Warning Signs* campaign which reported the presence of a short-term lag effect [6,10]. Cluster-robust estimates of standard errors were applied to account for clustering of observations within state. All models were adjusted for responder's demographics captured in the HeartWatch data (age, sex, level of education, primary language spoken, Aboriginal and/or Torres Strait Islander) and the presence of any self-reported cardiovascular risk factors.

Stratified analyses were undertaken to identify subgroups of interest amongst males and females, Aboriginal and/or Torres Strait Islanders and non-Indigenous responders, English and non-English primary language speakers, as well as amongst respondents who reported heart disease, hypertension, diabetes and hypercholesteraemia. The results are expressed as annual trends across the campaign and post-campaign periods and the immediate annual change comparing 2015 to 2014.

While the data was collected at quarterly intervals and analysed using yearly quarter as the independent variable, results across the campaign and post-campaign periods are reported as annual trends. Annual trends were calculated by multiplying the regression model coefficients by a constant and then exponentiating the result to provide an odds ratio.

All tests were two-tailed and assessed at the 5% alpha level. Adjustment for multiple testing was not undertaken as disjunction null hypothesis tests, which require such adjustments, were not undertaken [11].

Results

Over the study period (January 2010 to September 2020), there were 101,936 Australian adults aged between 30 and 59 years surveyed: 53% were female, 34% had a university qualification, 15% spoke a language other than English at home, 53% reported having a cardiovascular risk factor, and 2.1% were Aboriginal or Torres Strait Islanders (Table 1). There were significant differences across campaign periods on all demographic characteristics and self-reported risk factors (Table 1).

As is seen in Figure 1A and Table 2, respondents' awareness of chest and arm pain as symptoms of a heart attack was relatively high and stable during the campaign period and for the one-year lag period. However, after adjusting for differences in the sample over time, respondents' awareness of both chest pain and arm pain decreased significantly in both the first year (compared to the lag year, all $p<0.001$) and every year following the campaign (chest pain adjusted

Table 2 Impact of the *Warning Signs* campaign on Australian adults' awareness of chest pain, arm pain and inability to name any heart attack symptom (don't know).

	Chest pain			Arm pain			Don't know		
	OR	95% CI	P	OR	95% CI	P	OR	95% CI	P
Campaign activity (annual trend)									
Campaign	0.97	0.95, 1.01	0.11	1.00	0.98, 1.03	0.71	1.09	1.00, 1.19	0.05
Post-campaign	0.91	0.89, 0.92	<0.001	0.92	0.90, 0.94	<0.001	1.13	1.10, 1.15	<0.001
Immediate change (2015 v 2014)	0.67	0.56, 0.80	<0.001	0.76	0.69, 0.84	<0.001	1.74	1.06, 2.83	0.03
Age (years)									
30–34	0.55	0.49, 0.61	<0.001	0.55	0.51, 0.59	<0.001	2.31	2.01, 2.66	<0.001
35–39	0.65	0.61, 0.70	<0.001	0.66	0.60, 0.72	<0.001	1.88	1.65, 2.13	<0.001
40–44	0.73	0.68, 0.77	<0.001	0.73	0.69, 0.77	<0.001	1.63	1.42, 1.88	<0.001
45–49	0.80	0.74, 0.87	<0.001	0.85	0.80, 0.89	<0.001	1.39	1.22, 1.60	<0.001
50–54	0.90	0.83, 0.97	0.01	0.91	0.84, 0.99	0.03	1.25	1.11, 1.41	<0.001
55–59	1.00			1.00			1.00		
Sex									
Male	1.00			1.00			1.00		
Female	1.42	1.34, 1.51	<0.001	2.06	1.95, 2.18	<0.001	0.54	0.50, 0.58	<0.001
Education									
Year 12 or less	1.00			1.00			1.00		
TAFE/Vocational/Diploma	1.21	1.15, 1.27	<0.001	1.21	1.17, 1.25	<0.001	0.72	0.67, 0.77	<0.001
University	1.26	1.16, 1.38	<0.001	1.28	1.20, 1.37	<0.001	0.63	0.55, 0.72	<0.001
Aboriginal and Torres Strait Islander									
No	1.00			1.00			1.00		
Yes	0.69	0.52, 0.91	0.008	0.81	0.68, 0.95	0.01	1.78	1.30, 2.42	<0.001
Language other than English									
No	1.00			1.00			1.00		
Yes	0.56	0.52, 0.59	<0.001	0.54	0.51, 0.58	<0.001	1.75	1.64, 1.87	<0.001
Any cardiovascular risk factor									
No	1.00			1.00			1.00		
Yes	1.06	1.01, 1.11	0.008	1.11	1.06, 1.16	<0.001	0.87	0.80, 0.94	<0.001

Abbreviations: OR, odds ratio; CI, confidence intervals; TAFE, Technical and Further Education.

odds ratio [AOR] =0.91, 95%CI: 0.56–0.80, p<0.001; and arm pain AOR=0.92, 95%CI: 0.90–0.94, p<0.001), compared to the campaign period. Awareness of other types of pain (jaw, back, shoulder and neck pain) and some associated symptoms (shortness of breath and sweating) as heart attack symptoms were seen to increase during the campaign, but followed a similar downward trend after the campaign (Figures 1B and 1C).

Conversely, as seen in Figure 2, the proportion of respondents unable to name a single heart symptom increased in the period following the campaign (3.7% in 2010 to 19.9% in 2020), after adjusting for demographics there was an increase in each year following the campaign of 13% (AOR=1.13, 95%CI: 1.10–1.15, p<0.001) (Table 2 and Figure 1A). Respondents who were unable to name a single symptom were more likely to be male, younger than 55 years, have less than or 12 years of education, identify as Aboriginal and/or Torres Strait Islanders, speak a language other than English at home and report no cardiovascular risk factors. Statistical models in subgroups showed similar adjusted trends (Table 3).

Discussion

Our study suggests the awareness of ACS symptoms in middle-aged Australian adults was greatest during the years the *Warnings Signs* campaign was active, but has steadily decreased in the following seven years. Of particular concern, by 2020 only 50% of respondents reported chest pain as a heart attack symptom and one in five adults could not name a single symptom. These results were consistent across most demographic subgroups and in respondents with self-reported cardiovascular risk factors.

While baseline data were not available, the results suggest no increase was seen in the awareness of the more common symptoms of ACS (i.e., chest and arm pain) across the campaign period. This may have occurred because those who saw or heard the campaign materials were already aware of these symptoms as they are commonly used to portray heart attack symptoms in the media. Studies in Australian ACS patients cite television as a common source of heart attack information [12], and a survey conducted in

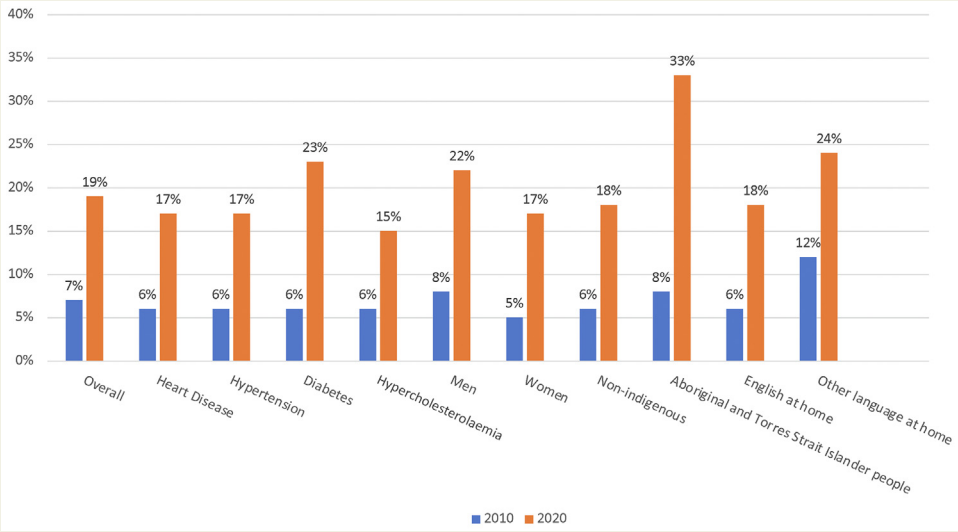

Figure 2 An unadjusted subgroup comparison of the proportion of respondents unable to name a single heart attack symptom in the years 2010 and 2020 (all $p<0.001$).

the Australian state of Victoria in the early 2000s showed similar rates of chest pain (84.5%) and arm pain (56.1%) to those reported in our study [13]. International surveys have also reported high awareness of chest pain (68% to 90%) but more variable awareness of arm pain (14% to 70%) and other symptoms in the general public [14–17]. Importantly, one study reported 68% of ACS patients who were aware of the *Warning Signs* campaign stated it increased their awareness of symptoms [4], and a prominent effect of the campaign in our findings was an increase in the lesser-known regions of pain (e.g., jaw, shoulder, neck and back) which was one of the aims of the campaign.

A recent systematic review reported that the few international studies that examined the impact of mass media campaigns on the public's symptom knowledge were mostly conducted in small, localised samples [7]. A strength of our study is the large and national sample. The highest quality study, the Rapid Early Action for Coronary Treatment (REACT) trial [18] in the USA, used a randomised controlled design to examine public symptom knowledge following an 18-month public and patient education campaign in pair-matched communities. These authors reported intervention communities had only a modest increase in their knowledge of the number of heart attack symptoms, compared to control communities, and that this effect appeared to take approximately 12 months to be realised [19]. However, awareness of chest pain was high in both the intervention and control groups at baseline, and there was no real effect for any other specific symptom [19].

Our findings of a significant impact on symptom knowledge during the campaign are in alignment with other evaluations of the *Warning Signs* campaign. These, population-based studies conducted in Victoria, report an increase in EMS use in ACS and chest pain patients [10,20], and a decrease in out-of-hospital cardiac arrest incidence [6]. Evaluations in other regions of Australia, which also report high awareness of the campaign, showed no effect of the campaign on EMS use in patients with suspected ACS or on time to presentation in ACS patients [21–23]. However, these three studies were conducted in single centres using convenience samples and were likely to be underpowered to detect any effect.

Our study is the first we are aware of examining the long-term effects following a mass media heart attack warning signs campaign. Our data suggest any knowledge gains from large-scale mass media campaigns are only seen for the following year. Studies of campaigns for other conditions, such as stroke, have found continuous impacts with short-term annual mass media campaigns [24,25], suggesting the need for ongoing public awareness messages. However, such campaigns are expensive and need to compete with other health messaging. Lessons learnt from the REACT trial suggest a better use of funds and resources may be to direct messaging to those who are at the highest risk and in whom the message has not yet penetrated [18].

Similar to our findings, the previous Victorian and international surveys have also reported lower symptom awareness in subgroups of the public including men [13,26], those with lower levels of education [13] or no history of heart disease [13,16], and in culturally and linguistically diverse populations [13,16,26]. Our study also identified lower awareness of symptoms in Aboriginal and/or Torres Strait Islanders who are harder to reach with health messaging and in whom co-design of interventions is recommended [27]. The declining awareness of heart attack symptoms seen across all subgroups, including those who are at higher risk with cardiovascular risk factors, since the *Warning Signs* campaign is alarming. New methods are needed to improve overall knowledge, reach hard-to-reach groups, and sustain

Table 3 Impact of the Warning Signs campaign for awareness of chest pain, arm pain and inability to name any heart attack symptom (don't know) for the stratified analysis in specific groups.

	Chest pain			Arm pain			Don't know		
	OR	95% CI	P	OR	95% CI	P	OR	95% CI	P
Self-reported heart disease									
Campaign activity (annual trend)									
Campaign	0.99	0.92, 1.06	0.79	0.99	0.95, 1.03	0.59	1.04	0.93, 1.18	0.48
Post-campaign	0.94	0.87, 1.01	0.08	0.93	0.90, 0.97	<0.001	1.09	1.01, 1.17	0.03
Immediate change (2015 v 2014)	0.49	0.36, 0.67	<0.001	0.71	0.58, 0.88	0.001	2.74	1.64, 4.56	<0.001
Self-reported hypertension									
Campaign activity (annual trend)									
Campaign	0.97	0.94, 1.01	0.14	1.01	0.98, 1.04	0.62	1.09	1.02, 1.16	0.01
Post-campaign	0.90	0.88, 0.91	<0.001	0.94	0.91, 0.96	<0.001	1.14	1.11, 1.17	<0.001
Immediate change (2015 v 2014)	0.70	0.59, 0.85	<0.001	0.73	0.64, 0.83	<0.001	1.75	1.14, 2.71	0.01
Self-reported diabetes									
Campaign activity (annual trend)									
Campaign	1.00	0.95, 1.04	0.92	1.01	0.97, 1.05	0.74	1.08	1.00, 1.16	0.04
Post-campaign	0.89	0.86, 0.92	<0.001	0.91	0.87, 0.94	<0.001	1.15	1.11, 1.20	<0.001
Immediate change (2015 v 2014)	0.64	0.49, 0.83	0.001	0.77	0.68, 0.88	<0.001	1.65	1.11, 2.46	0.01
Self-reported hypercholesteraemia									
Campaign activity (annual trend)									
Campaign	1.01	0.97, 1.04	0.71	1.02	0.99, 1.06	0.24	1.05	0.96, 1.15	0.26
Post-campaign	0.93	0.91, 0.95	<0.001	0.95	0.92, 0.97	<0.001	1.12	1.09, 1.17	<0.001
Immediate change (2015 v 2014)	0.62	0.52, 0.75	<0.001	0.72	0.61, 0.85	<0.001	1.88	1.21, 2.93	0.005
Males									
Campaign activity (annual trend)									
Campaign	0.98	0.94, 1.02	0.26	1.01	0.97, 1.06	0.54	1.05	0.98, 1.13	0.16
Post-campaign	0.90	0.89, 0.91	<0.001	0.91	0.88, 0.93	<0.001	1.13	1.10, 1.15	<0.001
Immediate change (2015 v 2014)	0.63	0.52, 0.78	<0.001	0.77	0.66, 0.89	0.001	1.82	1.22, 2.71	0.003
Females									
Campaign activity (annual trend)									
Campaign	0.97	0.95, 1.00	0.03	1.00	0.98, 1.01	0.70	1.15	1.00, 1.32	0.05
Post-campaign	0.91	0.89, 0.94	<0.001	0.93	0.91, 0.95	<0.001	1.12	1.08, 1.17	<0.001
Immediate change (2015 v 2014)	0.71	0.62, 0.83	<0.001	0.76	0.70, 0.82	<0.001	1.61	0.84, 3.11	0.15
Aboriginal and Torres Strait Islander Peoples									
Campaign activity (annual trend)									
Campaign	0.95	0.86, 1.05	0.31	1.01	0.85, 1.20	0.89	1.28	1.06, 1.54	0.009
Post-campaign	0.85	0.79, 0.93	<0.001	0.85	0.77, 0.93	0.001	1.20	1.09, 1.33	<0.001
Immediate change (2015 v 2014)	0.84	0.64, 1.12	0.24	0.71	0.45, 1.12	0.14	0.87	0.44, 1.75	0.70
Non-Indigenous									
Campaign activity (annual trend)									
Campaign	0.98	0.95, 1.01	0.12	1.00	0.98, 1.03	0.70	1.08	0.99, 1.19	0.07
Post-campaign	0.91	0.89, 0.93	<0.001	0.92	0.91, 0.94	<0.001	1.12	1.10, 1.15	<0.001
Immediate change (2015 v 2014)	0.67	0.56, 0.79	<0.001	0.76	0.69, 0.84	<0.001	1.77	1.09, 2.88	0.02
Language other than English at home									
Campaign activity (annual trend)									
Campaign	1.00	0.96, 1.04	0.94	0.94	0.92, 0.97	<0.001	1.04	0.98, 1.11	0.20
Post-campaign	0.92	0.90, 0.95	<0.001	0.92	0.90, 0.95	<0.001	1.08	1.04, 1.13	<0.001
Immediate change (2015 v 2014)	0.58	0.50, 0.69	<0.001	0.81	0.72, 0.90	<0.001	1.85	1.39, 2.47	<0.001
Speaks English only at home									
Campaign activity (annual trend)									
Campaign	0.97	0.94, 1.00	0.05	1.01	0.99, 1.04	0.35	1.10	1.00, 1.21	0.05
Post-campaign	0.90	0.89, 0.92	<0.001	0.92	0.90, 0.94	<0.001	1.14	1.11, 1.16	<0.001
Immediate change (2015 v 2014)	0.69	0.58, 0.83	<0.001	0.76	0.68, 0.84	<0.001	1.71	0.98, 2.97	0.06

Abbreviations: OR, odds ratio; CI, confidence intervals; TAFE, Technical and Further Education.

knowledge gains. Such interventions could also consider targeting regions with high rates of ACS which can be identified in some regions of Australia through the Heart Foundation's Heart Maps. [28].

Limitations

As the NHFA is the main cardiovascular body in Australia, we are confident no other national heart attack campaigns have occurred since the *Warnings Signs* campaign. However, these results should be interpreted with caution considering the limitations of online surveys (e.g., responder bias and fraud), even with quota sampling to reflect some of the demographics of the underlying population, and the lack of pre-campaign data. The quota and online sampling methods used may mean that some sections of the population are under-represented. The generalisability of the findings to the wider Australian adult population may therefore be limited and requires further research.

Conclusion

Our data suggest large mass media campaigns are effective at educating the public on both typical and less common ACS signs and symptoms, but this effect is not maintained once exposure to advertising ceases. Mass media campaigns either need to be continued, or new approaches are needed, to ensure prompt recognition and response to signs and symptoms.

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Appendices

Supplementary data associated with this article can be found, in the online version, at https://doi.org/10.1016/j.hlc.2023.01.010

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