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Obesity-related health impacts of active transport policies in Australia – a policy review and health impact modelling study

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Abstract

Objective: To review Australian policies on active transport, defined as walking and cycling for utilitarian purposes. To estimate the potential health impact of achieving four active transport policy scenarios.

Methods: A policy review was undertaken, using key words to search government websites. Potential health benefits were quantified using a cohort simulation Markov model to estimate obesity and transport injury-related health effects of an increase in active transport. Health adjusted life years (HALYs) gained and healthcare cost savings from diseases averted were estimated. Budget thresholds to achieve cost-effectiveness were estimated for each scenario.

Results: There is broad recognition of the health-related benefits of active transport from all levels of Australian government. Modelling results suggest significant health-related benefits of achieving increased prevalence of active transport. Total HALYs saved assuming a one-year effect ranged from 565 (95%UI 173-985) to 12,105 (95%UI 4,970-19,707), with total healthcare costs averted ranging from \$6.6M (95%UI \$1.9M-11.3M) to \$141.2M (95%UI \$53.8M-227.8M).

Conclusion: Effective interventions that improve rates of active transport may result in substantial healthcare-related cost savings through a decrease in conditions related to obesity.

Implications for public health: Significant potential exists for effective and cost-effective interventions that result in more walking and cycling.

Key words: obesity, active transport, policy

Given the high prevalence of non-communicable diseases associated with physical inactivity worldwide, governments are increasingly focusing on policies and interventions to encourage people to be more physically active.[1] The transportation sector has been recognised for its potential to incorporate more incidental physical activity (PA) into the daily lives of populations through active transport (AT, defined as walking, cycling and using public transport). While the central aim of transport policy is to achieve objectives related to the functioning of the transport system, the significant co-benefits of transport systems that encourage more AT are increasingly recognised.[2]

While mortality-related health benefits of walking and cycling are well-established,[3] there is a growing focus on better understanding the morbidity-related benefits related to diseases linked to physical inactivity, such as obesity.[4] Evidence suggests that the health benefits of AT are greater than potential negative health impacts related to exposure to traffic accidents or air pollution.[5,6] Yet, despite this recognition of the role that AT may play in improving the health of populations, the over-riding transport paradigm in Australia remains motor vehicle focused. In 2012, only 4% of Australian adults walked, 2% cycled and 16% used public transport to travel to work or full-time study.[7]

Approximately 57% of the Australian adult population do not meet recommended PA targets.[8] The burden of obesity is also high, with 35% of the Australian adult population considered overweight (body mass index [BMI] of between 25.0 and 29.9) and 27% obese (BMI greater than 30).[9]

Several studies have quantified the potential health impacts of an uptake in AT internationally.[6] However, relatively few of these studies have been undertaken in Australia, despite the growing recognition of the potential population health benefits of investing in 'upstream' interventions to improve obesogenic environments.[10] Such studies provide important information on the effectiveness and cost-effectiveness of policies and interventions to encourage AT and can assist decision makers with information on practical ways to achieve policy goals. This paper therefore seeks to review current Australian AT policies and

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to quantify potential obesity-related health impacts of achieving hypothetical policy targets. Estimates will then be used to explore the potential threshold for cost-effectiveness of interventions that may lead to improved rates of AT.

Methods

Policy review

A search of Australian State and Federal Government health and transport websites was conducted for policies related to AT. Search terms included "active transport", "active travel", "walking for transport" and "cycling for transport". National non-government organisations with AT policies were also searched, by conducting a Google search combining the terms "active transport" or "active travel" or "walking for transport" or "cycling for transport" and "policy" and reviewing the first 10 pages of hits. Policy documents were reviewed and key data relating to policy context, aims and goals were extracted (Supplementary material). Data extraction included specific AT goals outlined as part of the policy document (where applicable), as well as the potential health impacts recognised within the policy (categorised as related to PA, injuries and safety or emissions). Policy responses were categorised as pertaining to the provision of infrastructure to support AT, planning, AT promotion, monitoring and evaluation and "other" (including policy responses such as education and governance).

To limit the scope for this review, specific local government policies around AT have been excluded. Local government does, however, play a significant role in the delivery of localised interventions to encourage AT. Therefore, websites of local governments listed in the relevant State or Territory index were searched using the terms "active transport", "active travel", "cycling", "bicycle", "walking" and "transport". The proportion of local councils with a visible online focus on AT (through policies, strategies, programs) within each jurisdiction was then tallied. The policy search was conducted by one author (VB).

Health impact modelling of AT policy goals

Findings from the policy search informed the development of four scenarios for health impact modelling. A macro simulation model was used to estimate the changes in health adjusted life years (HALYs) arising from changes in AT behaviours for the 2010 Australian population.[11] The proportional multi-state multi-cohort lifetable model compared the obesity and transport injury-related costs and consequences of a population that was exposed to the increase in AT to a status quo population. Data on the prevalence of transport behaviours are relatively limited in Australia, particularly for active modes. National level data on method of travel to work are collected every five years as part of the Australian Bureau of Statistics (ABS) Census of Population and Housing.[11] Therefore, scenarios were developed as changes in the prevalence of AT to work or full-time study.

Physical activity effect was estimated using relevant input parameters (Table 1) and modelled to BMI effect using the energy balance equation by Hall et al.[12] (Supplementary material). Due to the hypothetical nature of the effect estimates and the fact that limited evidence exists on the potential for sustainability of these effects, the change in BMI was assumed to last for one year and health impacts and cost savings of this change in behaviour were modelled over the lifetime. Health outcomes were estimated from the changes in incidence of nine obesity-related diseases (ischaemic heart disease, hypertensive heart disease, ischaemic stroke, diabetes, colorectal cancer, kidney cancer, breast cancer, endometrial cancer and osteoarthritis). Potential impact fractions (PIFs) quantified the reduction in disease incidence occurring from exposure to the intervention, compared to the 'do nothing' scenario. Changes in disease incidence lead to corresponding changes in disease prevalence in later years of life, and changes in mortality and years lived with disability (YLD). Epidemiological data were derived from the Global Burden of Disease (GBD) 2010 study,[13] using DISMOD II[14] for parameters not explicitly reported. Ninety-five per cent uncertainty intervals for input parameters were determined by Monte Carlo simulation (2,000 iterations) using Ersatz (version 1.34),[15] see Table 1.

The impact of modal switch from the relatively safer confines of motor vehicle transport to walking or cycling on traffic injuries was also estimated using a 'risk injury matrix' approach.[16] The matrix estimates the change in absolute numbers of mode-specific fatalities and serious injuries as a result of an intervention and then compares with baseline deaths and YLD from the GBD study 2010.[13] To produce conservative estimates, transport injury effect was also modelled assuming the change in transport behaviour lasted for one year. Healthcare costs were estimated using data from the Australian Institute of Health and Welfare,[17] adjusted to 2010 values. Discounting was undertaken at 3% for costs and consequences.

Results are presented as estimates of obesity and injury-related HALYs and total healthcare cost savings assuming a behavioural change lasting one year, modelled over the cohort's lifetime. Results are also estimated taking into account only obesity-related consequences (i.e. omitting transport injury-related costs and consequences), see Supplementary material. Budget thresholds to achieve cost-effectiveness from a healthcare payer's perspective were estimated using the concept of incremental cost-effectiveness ratios (ICERs). The ICER is the ratio of the change in costs to incremental benefits from an intervention. To estimate budget thresholds, we used the $50,000 ICER threshold as per Australian benchmarks.[18] All amounts are in Australian dollars (AUD).

Results

AT policies in Australia

Recently, there has been an increased focus on the potential benefits of AT in Australia, both at the national and state levels. Nine policy statements or documents were found nationally. The Ministerial Statement on Walking, Riding and Access to Public Transport released in 2013[19] marked the first time a Federal Government approach to increasing rates of walking and cycling has been undertaken in Australia. While the statement brought a national focus to the many benefits of increasing AT, it fell short in terms of setting any detailed policy goals or providing specific funding to achieve a higher modal share for walking and cycling. However, a recent positive development has been the newly revised Australian Transport Assessment and Planning Guidelines,[20] which now incorporate mode-specific guidance for undertaking economic appraisal of AT interventions and initiatives.

All Australian states and territories have endorsed some form of AT policy or position statement, demonstrating awareness at the state government level of the value of encouraging more walking and cycling. State and territory government policies tend, however, to focus on cycling strategies over

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policies to increase rates of walking, with several policies aimed at mainstreaming the provision of cycling facilities as part of transportation projects. While there may be significant health benefits of improving rates of cycling, the main justification for these types of policies is the development of integrated multi-modal transport projects and avoidance of potentially expensive retro-fitting of infrastructure. Fewer than half of the state-level policies (only 5 of 13 state-level policy documents) examined identified specific AT goals.[21-25] Only 37% of Australian local governments have a visible online focus on AT, although this relatively low number may more accurately reflect the quality of information available on local government websites rather than actual commitment to AT policies and programs.

Overall, there was broad recognition of the wider health benefits of AT, including effects on physical inactivity, injuries and emissions (Supplementary material). The most commonly cited policy responses to improving rates of AT included provision of supportive infrastructure (referred to in 90% of the policy documents examined)[19,21-39] and planning responses (referred to in 81% of the policy documents examined).[21-35,38,39] Policy responses around health promotion were recommended in 62% of included documents,[19,21,23,25-27,29,30,32-34,37,38] with 38% explicitly recognising the importance of monitoring of AT behaviours.[19,23,25-27,34,37,38]

Health impact of achieving AT targets and potential for cost-effectiveness

The limited policy goals that have been quantified in Australian AT documents (Supplementary material) focus on either a defined multiplier of current prevalence of AT, or achieving a defined proportion of the population engaging in AT. Therefore, four scenarios based on relevant policy goals were modelled:

- Doubling of current rates of cycling commuting (*Scenario 1*)
- Doubling of current rates of walking commuting (*Scenario 2*)
- Achieving 30% commuting modal share in capital cities by cycling (*Scenario 3*)
- Achieving 30% commuting modal share in capital cities by walking (*Scenario 4*).

Key modelling parameters are given in Table 1.

Our results suggest that doubling current rates of walking or cycling would lead to significant HALYs and healthcare cost offsets (Table 2). Given that more people walk to work than cycle in Australia, the doubling of AT prevalence results in greater benefits under the walking scenario (*Scenario 2*) than the cycling scenario (*Scenario 1*). It should be noted, however, that we have used a conservative metabolic equivalent task (MET) value for cycling, which may underestimate the associated PA and obesity-related health benefits of an increase in cycling. If we assume the higher MET value of 6.8 (defined as "cycling to work, self-selected pace")[41] with all other input parameters for *Scenario 1* as per our main analysis, 1,088 HALYs (95%UI 354-1,882) and $12.8 million in healthcare costs (95%UI $4M-$22.3M) would be saved assuming a one-year effect and modelling over the lifetime.

The benefits of achieving 30% of commuting modal share in capital cities by either walking

Table 1: Key model input parameters.

Parameter	Mean values and 95%UI[a]			Distribution	Source and assumptions
Proportion of population who cycle to work, baseline		Males	Females	N/A	ABS Census of Population and Housing 2011[11]
	18y	0.7%	0.15%		
	19y	0.68%	0.19%		
	20-24y	0.85%	0.34%		
	25-29y	1.26%	0.58%		
	30-34y	1.59%	0.54%		
	35-39y	1.6%	0.39%		
	40-44y	1.46%	0.34%		
	45-49y	1.25%	0.34%		
	50-54y	1.05%	0.28%		
	55-59y	0.77%	0.2%		
	60-64y	0.44%	0.08%		
Proportion of population who walk to work, baseline		Males	Females	N/A	
	18y	2.81%	3.07%		
	19y	3.08%	3.32%		
	20-24y	3.03%	3.27%		
	25-29y	3.45%	3.5%		
	30-34y	3.03%	2.6%		
	35-39y	2.47%	2.02%		
	40-44y	2.26%	2.08%		
	45-49y	2.29%	2.32%		
	50-54y	2.42%	2.52%		
	55-59y	2.42%	2.27%		
	60-64y	1.91%	1.59%		
Mean km/day commuting by cycling	Males 14.9km (95%UI 14.89-14.92) Females 11.64km (95%UI 11.62-11.66)			Lognormal	VISTA.[40] We assume that mean km/day commuting by bicycle as per VISTA is representative across the entire Australian population. Converted to time spent cycling assuming MET value of 4 equates to speed of 16 km/hr.
Mean km/day commuting by walking	Males 3.12km (95%UI 3.11-3.12) Females 3.26km (95%UI 3.25-3.26)			Lognormal	VISTA.[40] We assume that mean km/day commuting by walking as per VISTA is representative across the entire Australian population. Converted to time spent walking assuming MET value of 4 equates to speed of 5 km/hr.
Marginal MET cycling to work	3 (95%UI 1-6)]			Lognormal	MET value of 4 (bicycling, <10mph, to work or for pleasure) adjusted for inactivity,[41] stdev 1.3.[42] Note this is a relatively conservative MET value, and will be tested under sensitivity analysis using MET value 6.8 (bicycling, to/from work, self-selected pace).
Marginal MET walking to work or class	3 (95%UI 1-7)			Lognormal	MET value of 4 (walking to work or class) adjusted for inactivity,[41] stdev 1.6[42]
Number of working weeks per year	49 (95%UI 46-52)			Uniform	Sampled from a uniform distribution with min 46, max 52 weeks (variability by author discretion)

a: 95% uncertainty interval (UI) based on 2,000 simulations.

Mins: minutes. stdev: standard deviation. min: minimum. Max: maximum. km: kilometre. hr:hour. ABS: Australian Bureau of Statistics. VISTA: Victorian Integrated Survey of Travel and Activity. Y: years of age. MET: metabolic equivalent task, marginal MET values refer to the intensity of activity over the standard resting metabolic rate of 1.0. mph: miles per hour.

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or cycling are high, with the potential for millions of dollars to be saved in healthcare costs per year (Table 2). Again, if we conduct sensitivity analysis around the choice of MET value for cycling in *Scenario 3* and assumed the higher MET value of 6.8, the resultant health-related benefits would be higher (22,097 HALYs (95%UI 9,396-34,285) and $259 million in healthcare costs (95%UI $109.3M-$405M) saved assuming a one-year effect and modelling over the lifetime).

Potential spending thresholds to achieve cost-effectiveness vary between scenarios, but fall within the range of $34.9 million (95%UI $20M-51.2M) to $746.5 million (95%UI $476M-$1B) to achieve the modelled uptake in AT when including BMI and injury-related effects (Table 2). If we relate these budget thresholds to the required number of people taking up AT in order to achieve each policy goal, this would equate to an approximate spend per new active traveller of up to $335 for *Scenario 1* (95%UI $192-$492), $203 for *Scenario 2* (95%UI $135-$279), $433 for *Scenario 3* (95%UI $277-$603) and $335 for *Scenario 4* (95%UI $220-$447) to achieve the $50,000 cost-effectiveness threshold.

The change in mode of transport also results in a change in risk of transport-related mortality and morbidity. Results from our analyses suggest that a modal shift from motor vehicle travel to either walking or cycling under each scenario would lead to an increase in transport-related mortality and years lived with disability (YLD), see Table 3. Results suggest, however, that any negative transport injury-related effect is relatively small and far outweighed by the positive obesity-related health benefits of a shift to AT (Table 2). This suggests that while interventions designed to achieve an uptake in AT should consider impacts on improvements in safety for cyclists and pedestrians, they should also focus on changing people's perception of safety of active modes, given the potential for other positive health benefits.

Discussion

Our analysis of Australian AT policies demonstrates that recognition of the potential health benefits of more walking and cycling is occurring across all levels of Australian government. In fact, AT became a policy platform at the last Australian federal election in 2016.[43,44] Changes in leadership, however, often result in changes in policy direction and scope, and Australia has had several leadership changes in recent years. The Ministerial Statement on Walking, Riding and Access to Public Transport[19] was the first time that a national approach to AT policy was taken. The National Cycling Strategy[26] ended in 2016 and there are currently no firm plans to develop future strategies for cycling in Australia at the federal level. A review in 2015 found that cycling had not significantly increased or decreased over the life of the strategy.[45]

It is increasingly recognised that the demand for walking and cycling is influenced by the level of infrastructure to support and encourage it.[46] A lack of infrastructure for walking and cycling is commonly cited as a barrier to the uptake of active forms of transport, with a recent survey of Australian adults finding that issues surrounding cycling safety and lack of provision of infrastructure ranked highly among reasons for not cycling to work or full-time study.[8] A 2015 study found that almost one in three people did not walk for either leisure or transport due to a lack of infrastructure for walking.[47] Infrastructure to support AT was consistently recognised as an important policy response to improve rates of walking and cycling in Australia within our analysis. The recognition that more supportive infrastructure is required has also been reflected in Infrastructure Australia's recent priority list for Australia, which highlighted a number of projects including AT as "high priority" and "priority" initiatives.[48]

Supportive infrastructure will be an important component of improving AT prevalence, but it should be noted that other approaches to intervention will also be required. A recent study in the UK found that infrastructure provision may be a necessary, but not sufficient, condition for encouraging modal shift.[49] Changing travel behaviours is a complex undertaking and a variety of supportive measures spanning environmental, economic, legal, social, cultural and educational approaches will likely be required. Our policy review also demonstrates the relative dominance of cycling-related AT policies within Australia. While the health benefits of cycling may be greater than that of walking (given the potential for higher intensity), it is also important that walking be promoted as a relatively simple, low cost alternative to motorised transport. This may be particularly important in encouraging AT among some groups (for instance, women, children and the elderly). It should also be noted that the interventions most successful in promoting walking may differ from those successfully encouraging cycling, due in part to these demographic differences and also to the realistic distances able to be travelled by each respective mode.

Table 2: Results of scenario analyses.

Results	Scenario			
	1. Doubling rates of cycling	2. Doubling rates of walking	3. 30% cycling for commuting trips in capital cities	4. 30% walking for commuting trips in capital cities
BMI and transport-related injury effect				
Total HALYs saved	565 (95%UI 173-985)	1,187 (95%UI 523-1,893)	12,105 (95%UI 4,970-19,707)	9,003 (95%UI 4,035-13,962)
Total healthcare cost savings[a]	$6.6M (95%UI $1.9M-$11.3M)	$14M (95%UI $6M-$22.4M)	$141.2M (95%UI $53.8M-227.8M)	$105.9M (95%UI $46M-$164.7M)
Total budget threshold for cost-effective interventions that achieve the modelled increase in AT[b]	$34.9M (95%UI $20M-$51.2M)	$73.3M (95%UI $48.6M-$100.7M)	$746.5M (95%UI $476M-$1B)	$556M (95%UI $366.4M-$744.1M)

a: All monetary values reported are in 2010 Australian dollars.
b: maximum budget to achieve incremental cost-effectiveness ratio (ICER) of $50,000.
B: billion. BMI: body mass index. PA: physical activity. HALYs: health adjusted life years. M: million. B: billion. 95%UI: 95% uncertainty interval. Values based on 2,000 simulations.

Table 3: Injury effect of achieving uptake in AT as per scenarios.

Injury effect	Scenario			
	1. Doubling rates of cycling	2. Doubling rates of walking	3. 30% cycling trips in capital cities	4. 30% walking trips in capital cities
Difference in mortality	+1	+22	+13	+94
Difference in YLDs	+28	+18	+382	+78

YLDs: years lived with disability.

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While a number of studies have been undertaken that quantify health impacts of AT, a direct comparison of results is not possible due to differences in methodologies and modelling. Gotschi et al.[42] estimated that between 150,000 to 250,000 disability adjusted life years (DALYs) would be averted per year if the UK achieved rates of walking and cycling similar to those found in Switzerland or the Netherlands. In their Australian study, Xia et al.[50] estimated that the PA-related health benefits of shifting 40% of vehicle miles travelled in Adelaide to AT would equate to 6,569 DALYs averted per year. Again, while the methods used differed, our results also support the potential for significant health benefits of increased rates of walking and cycling for transport.

Results suggest significant healthcare cost savings may equate to relatively sizeable budget thresholds for cost-effectively achieving and maintaining the increase in AT. This suggests the potential scope for spending by all levels of Australian government on effective interventions that encourage AT. The cost-effectiveness thresholds for achieving specified policy targets as presented in our results provide useful information in terms of 'value for money' for policy-makers and should be considered within the governmental agenda-setting process.

This study takes the next step and estimates budget thresholds for achieving specified targets cost-effectively; however, this still brings us no closer to ascertaining actual, definable and measurable ways in which AT rates could be increased in the real world (and not using hypothetical assumptions). This represents the most challenging part of the problem – quantitative effects of specific policies to encourage AT remain very poorly understood.[42] A comprehensive policy approach bundling together 'packages' of interventions is most likely required to achieve optimal outcomes, but is also very difficult to measure and value.[51] A further complication is that several of these influences will also be contextual, meaning that generalisation across different areas or countries with differing legal, environmental and cultural backgrounds will be difficult. Limited studies have been undertaken to assess the cost-effectiveness of actual interventions that may improve AT.[52,53] Much more research is required within this field, first in measuring the effect of potential interventions and then building upon this health impact modelling to undertake full economic evaluations to determine cost-effectiveness.

A higher modal share of AT is, however, an achievable target within Australia, given adequate political motivation and funding for effective and cost-effective AT interventions. Australia's average commuting distance was 15.6km in 2011.[54] On average, 29% of Australian commuters live within five kilometres of work, with a further 21% living within five to ten kilometres.[54] This means that for 50% of the Australian population, improving health through an increase in active commuting may be a realistic goal. However, the distribution of commuting distance varies by geographical location; those living in inner areas of capital cities generally experience shorter commutes than those living in outer city areas, and those living in capital cities generally experience shorter commutes than those living in rural and remote regions. Evidence also suggests that persons in lower socioeconomic groups have longer commutes and may be less likely to commute actively.[55] An awareness of the potential for transport environments to contribute to a reduction in health inequities will therefore be crucial in designing interventions to promote AT across all social groups and to improve the health of both rural and urban populations.[2]

A limitation of our study is the availability of data to inform our economic modelling. The BMI effect estimates used in all scenarios are based on validated input parameters and sound reasoning, but are modelled effects. A review of the literature demonstrates that they are feasible, however, with the study by Flint et al.[56] estimating the difference in BMI between private transport and AT commuters as -0.97kg/m^2 in men (95%UI -1.55 to -0.40kg/m^2) and -0.87kg/m^2 in women (95%UI -1.37 to -0.36kg/m^2). Cross-sectional results from another study in adults aged 40 to 69 years[57] found BMI differences between cyclists and car commuters of -1.71kg/m^2 in men (95%UI -1.86 to -1.56kg/m^2) and -1.65kg/m^2 in women (95%UI -1.92 to -1.38kg/m^2).

Other limitations are that our desktop policy analysis required AT policies to be visible on government websites and that our modelling only accounts for commuting travel, although the journey to work contributes only a relatively small proportion of regular travel patterns. This likely results in an underestimation of potential health benefits should policies and interventions be successful in improving AT modal share across both leisure and utilitarian trips.

Conclusion

Our study provides an overview of AT policy in Australia, highlighting the relative importance placed on the planning and provision of supportive built environments and the cycling focus of current policies. Our estimates demonstrate the potential value of devoting time and resources to better understanding the travel behaviours of Australians, and then using this knowledge to improve rates of AT. Health impact modelling of achieving AT policy goals demonstrates significant health-related benefits and the potential for healthcare cost savings. Although improving rates of walking and cycling would result in higher numbers of transport-related deaths and injuries, the effect is small and far outweighed by the health benefits from reductions in body weight. However, interventions to increase the prevalence of AT that also improve safety and/or the perception of safety may be important in encouraging walking and cycling for transport.

Ethics approval and consent to participate

Ethics exemption has been granted from Deakin University Human Research Ethics Committee (2016-037).

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Supporting Information

Additional supporting information may be found in the online version of this article:

Supplementary Table 1: Key national and state AT policies, Australia.

Supplementary Table 2: Count of State and Territory local council with AT focus.

Supplementary Table 3: Scenarios modelled to BMI effect, effect per individual new to active travel.

Supplementary Table 4: Results of scenario analyses, BMI effect only.

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