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Evaluation of a community wayfinding signage project in Hawaiʻi: Perspectives of pedestrians and bicyclists

L. Brooke Keliikoa[a,*], Michael Y. Packard[b], Heidi Hansen Smith[c], Inji N. Kim[a], Kelly A. Akasaki[d], David A. Stupplebeen[a]

[a] University of Hawaiʻi at Mānoa, Office of Public Health Studies, 1960 East-West Road, Biomed D104, Honolulu, HI 96822, USA
[b] SSFM International, Inc., 501 Sumner Street, Suite 620, Honolulu, HI 96817, USA
[c] Hawaiʻi State Department of Health, Chronic Disease Prevention and Health Promotion Division, 1250 Punchbowl Street, Honolulu, HI 96814, USA
[d] City & County of Honolulu, Department of Transportation Services, 650 South King Street, 3rd Floor, Honolulu, HI 96813, USA

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ABSTRACT

Wayfinding signs can support active transportation by guiding pedestrians and bicyclists onto safer routes to community destinations. The purpose of this study was to assess the perceptions of pedestrians and bicyclists related to a community-wide wayfinding signage project implemented in Kailua, a suburban community in Hawaiʻi and an increasingly popular tourist destination. Wayfinding signs consisted of standard bicycle route confirmation and decision signs showing direction or distance to popular community destinations, including beaches and parks. Intercept surveys (n = 244) were conducted immediately and five months after the wayfinding signs were installed. Overall, 50.5% of pedestrians and 63.3% of bicyclists reported seeing a wayfinding sign along their route. Among those who saw a sign, 41.9% reported that it helped with route decision making. Logistic regression models revealed that those walking and bicycling the route for the first time had higher odds of seeing a wayfinding sign [OR (95% CI): 2.59 (1.07–6.27)]. Being a bicyclist, female, and non-resident were significantly associated with using a wayfinding sign. One-third (33.1%) of surveyed community residents agreed that seeing the wayfinding signs encouraged them to walk or bicycle more often in their community. Lastly, the majority of residents (82.6%) and non-residents (86.5%) thought the wayfinding signs were beneficial to the community. These evaluation findings indicate that wayfinding signs are useful environmental supports for active transportation, especially for those who are traveling along new routes. Additional programs or promotional activities are needed to complement wayfinding signage interventions to further encourage walking and bicycling trips.

1. Introduction

The wide-ranging health benefits of physical activity are clearly established (2018 Physical Activity Guidelines Advisory Committee, 2018). One way to accrue the recommended levels of physical activity is through active transportation, such as walking and bicycling. In place of driving, walking or bicycling for short trips presents a major opportunity for improving population health (Sallis et al., 2012). Walking and bicycling have been linked to reduced risk of all-cause mortality, improved cardiovascular health, and potentially reduced risk of diabetes (Hamer and Chida, 2008; Kelly et al., 2014; Saunders et al., 2013). To increase population-

* Corresponding author.
E-mail address: lehuac@hawaii.edu (L.B. Keliikoa).

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levels of walking and bicycling, pedestrian and bicycling facilities that enhance safety from traffic are needed (Sallis et al., 2012). As more people walk and bicycle in an area, pedestrian and bicyclist safety also increases (Jacobsen, 2003).

1.1. Wayfinding signs as environmental supports

Safer built environments for pedestrians and bicyclists can be achieved through a combination of education, engineering, and enforcement. Wayfinding signage is one engineering tool that can inform people walking and bicycling about the availability of safer walking/bicycling routes. Wayfinding signs are point-of-decision cues and aids that convey information about orientation and distance to help with navigation and route decision making (Hunter et al., 2016). Wayfinding signs also can serve as physical activity prompts by encouraging people to take the stairs or walk (Hunter et al., 2016; Fulton et al., 2017). In addition to promoting physical activity, wayfinding interventions can also promote economic development and reduce the risk for getting lost or injured (Hunter et al., 2013).

A comprehensive wayfinding system may be particularly critical for pedestrians: "as opposed to drivers or transit users, pedestrians are more sensitive to distance and more vulnerable should they exceed their functional limits or become lost" (Vandenberg et al., 2016, p. 5). This may be similarly true for people who fall into the "interested but concerned" category of bicyclists and need safe, comfortable routes (Dill and McNeil, 2016). Despite the potential benefits of wayfinding interventions for people walking and bicycling, there is a lack of research and evaluation characterizing effective practices and assessing outcomes (Hunter et al., 2016; Vandenberg et al., 2016). Evidence on wayfinding intervention outcomes primarily exists in the grey literature (Vandenberg et al., 2016). We are only aware of one evaluation study published in a peer-reviewed journal that links wayfinding signs to increased walking (Fulton et al., 2017). There is also a lack of published studies assessing the impact of wayfinding signage on levels of bicycling (Pucher et al., 2010).

1.2. Project description and setting

A wayfinding signage demonstration project was initiated in 2015 for the Kailua community, a suburb of the city of Honolulu, located in O'ahu, Hawai'i. Kailua features a compact, walkable town center adjoined by popular public beaches, parks, commercial centers and neighborhoods within walking and bicycling distance. The terrain is primarily flat and the weather is amenable year-round to active transportation. Kailua is home to approximately 40,000 residents and has become an increasingly popular destination for tourists. A local ordinance prohibits tour buses from dropping off tourists at public beaches. Instead, tourists are dropped off in the town center where nearby shops offer bicycle rentals as a means to travel from the town center to the beach, about one mile away. Community residents have expressed traffic safety and congestion concerns related to tourists (Gutierrez, 2016).

The wayfinding signage project had several goals: (1) help to alleviate traffic congestion concerns that residents attributed to an increasing number of tourists walking and bicycling in the community; (2) promote safety by guiding pedestrians and bicyclists onto routes with fewer potential conflicts with vehicles; and (3) provide environmental cues that encourage people to walk or bicycle instead of driving. Project partners included the State Department of Health (provided funding and planning support), a Hawai'i-based private sector planning and engineering firm (provided technical expertise in developing the wayfinding basis of design and signage plan), the City & County Department of Transportation Services (responsible for managing a contract to manufacture and install the wayfinding signs in public right of way), and the University of Hawai'i (conducted evaluation study).

The wayfinding signage plan consisted of bicycle signs that followed guidelines in the U.S. Manual on Uniform Traffic Control Devices for size, font, symbols, and mounting height (U.S. Federal Highway Administration, 2009). The Urban Bikeway Design Guide (National Association of City Transportation Officials, 2012) also informed the plan. As opposed to pedestrian-specific wayfinding that is typically concentrated in an urban core, bicycle signs were selected for the opportunity to implement community-wide. Destination signs were used to mark the junction between two or more travel destinations and displayed destinations, directional arrows, and distances (in miles). Distances were used as opposed to travel time since the purpose of these signs was to inform people both on foot and bicycle. Turn signs were used at intersections where the preferred route turns from one street onto another and included destinations and directional arrows.

Signs were intended to guide both pedestrians and bicyclists along routes that were deemed safer for walking and bicycling based on local knowledge, observation of travel patterns, and consultation with resources such as the O'ahu Bike Plan. Routes that had existing dedicated space for pedestrians and bicycles, availability of shoulders or other paved areas not in conflict with vehicles, and lower traffic volumes were prioritized. A total of 97 new signs displaying directional arrows or distances to key community destinations were added to Bike Route Guide signs (Fig. 1*a*) and Bike Lane signs (Fig. 1*b*). Similar signs devised for travel along a shared use path (Fig. 1*c*) were also added. Key community destinations included active living resources such as public parks and beaches.

1.3. Study objective

The overall purpose of this evaluation study was to assess the perceived impact of the wayfinding signs on people walking and bicycling. Specifically, we sought to answer the following questions: (1) do the wayfinding signs help people walking and bicycling navigate their way to key community destinations; (2) do the wayfinding signs serve as environmental cues that encourage people to walk or ride a bicycle more often in the community; and (3) are the wayfinding signs perceived as beneficial to the community?

Fig. 1. a. Wayfinding sign associated with Bike Route sign indicating direction to community physical activity destinations. b. Wayfinding sign associated with Bike Lane sign indicating direction to key community destinations. c. Wayfinding sign on shared use path indicating direction and distance (in miles) to town.

2. Methods

2.1. Study design

The study protocol was developed by the university evaluation team in collaboration with the project partners (Department of Health, Department of Transportation Services, and private-sector planning & engineering firm). Initially, a mixed methods approach consisting of pre-post pedestrian/bicyclist counts and intercept surveys was planned. However, installation of the wayfinding signs was delayed by over a year due to a slow contracting process and archeological constraints which required deviation from the original signage plan. As a result of the unanticipated delay, trained data collectors were no longer available to conduct pre-post pedestrian/bicyclist counts. Thus, the final study design was limited to post-implementation intercept surveys conducted in two waves. The evaluation study was approved by the University of Hawaiʻi Human Studies Program.

2.2. Sign audit

To verify project implementation, evaluation team members conducted a sign audit immediately following each wave of intercept surveys. Based on the wayfinding signage plan, a tracking sheet was generated for the signs in two areas where the intercept surveys were conducted (town center and beach park). Data collectors observed whether the sign was posted as designated by the plan and if it was visible from the viewpoint of a person passing by on foot or bicycle. If signs were obstructed, observers assessed whether visibility was partially or totally blocked and noted the cause of the obstruction. Each sign audit was performed by a pair of observers; four observers were used in total.

2.3. Intercept surveys

Intercept surveys with pedestrians and bicyclists were pilot tested in April 2016 and then conducted immediately following sign installation (Wave 1: May 2017) and five months later (Wave 2: October 2017). Pilot testing resulted in refining survey questions and determining locations where it was safe and feasible to administer the intercept surveys. Two survey locations were selected in the town center and near the gateway of a public beach park, close to an off-street shared use path. The locations were approximately one mile apart. Surveys were conducted simultaneously at both locations by teams of two or three data collectors. Altogether, 11 data collectors conducted the intercept surveys.

Data collection was scheduled for three different time periods outside of peak commute hours: weekday morning (~ 9:30–11:30 a.m.), weekday afternoon (~ 1:30–3:30 p.m.), and Saturday midday (~ 9:30–1:00). Weekday data collection occurred on a Tuesday, Wednesday, or Thursday. Data collection was also scheduled on weeks without major holidays and while public school was still in session. This schedule was designed to capture typical travel conditions and target trips made within the community for shopping or recreation that were more likely to fall within reasonable walking and bicycling distances.

Data collectors recorded the session start and end time, weather conditions, presence of nearby construction projects that may have affected traffic patterns, and the number of people approached to participate (to track the participation rate). The intercept survey was administered verbally in English, and the survey administrator recorded responses on a paper survey. The survey was also translated into Japanese, given that visitors from Japan represent a significant proportion of the state's tourism industry. Japanese-speaking participants provided written responses to the Japanese-language survey, and open-ended responses were translated by bilingual colleagues.

A nonrandom sampling strategy was employed to ensure the sample included a mixture of pedestrians and bicyclists, as well as residents and tourists. If several people were passing by at the same time, requesting participation from the following were prioritized: (1) bicyclists over pedestrians, and (2) those who appeared to be community residents over tourists. Otherwise, we attempted to recruit everyone who was passing by when survey administrators were available. For pedestrians and bicyclists who were traveling as part of a couple or small group, we asked one person to be the primary survey respondent, though in reality, the survey responses tended to be discussed.

In total, 244 intercept surveys were conducted (Wave 1: n = 89; Wave 2: n = 155). In the first wave of data collection, the sample was only 12.4% bicyclists. Thus, in the second wave of data collection, we intentionally tried to recruit more bicyclists. Survey administrators had to put extra effort into flagging down bicyclists because they were passing by more quickly than pedestrians and it was challenging to get them to stop to learn more about the study. Overall, approximately 28% of the pedestrians and bicyclists we attempted to recruit agreed to participate in the study. Pedestrians were more likely to agree to participate (32% participation rate) than bicyclists (21% participation rate) [χ^2 (1) = 8.64, p = 0.003].

Survey questions included trip origin and destination, trip purpose, reason for using chosen route, how many times the participant walked/bicycled in the survey intercept area over the past month, age group, and place of residence. Participants were shown examples of the wayfinding signs and asked if they saw any signs like it on their route that day. If they reported seeing a sign, they were asked if it helped them to choose their route that day and to explain why/why not. All participants then were asked if they thought that signs like those shown were beneficial to the community and whether or not signs would be helpful in other communities in Hawai‘i. In addition, community residents were asked how much they agreed or disagreed with the statement, “Seeing signs like this has encouraged me to walk or bike more often in [community].” Lastly, all participants were asked an open-ended question about whether they would like to share anything else about making it safer or easier for pedestrians and bicyclists to get around the community. The surveyor recorded the primary respondent's observed gender and mode of transportation (walking, bicycling, or other).

2.4. Data analysis

Survey data were analyzed using Stata 15.1 (StataCorp, College Station, TX). Data analyses included basic descriptive statistics, chi-square tests, and logistic regression. The first logistic regression model examined correlates of seeing a wayfinding sign along the participant's route. Among those who saw a wayfinding sign, the second logistic regression model examined correlates of using wayfinding signs to help make route decisions. Qualitative survey responses were inductively coded through an iterative process until agreement on categories and themes was achieved by two coders.

Three surveys (1.2%) with missing data on key variables were excluded from data analysis, resulting in a final sample of 241 surveys. The response options for several variables were recoded to facilitate data analysis. Two participants (one skateboarder and one person on a motorized scooter) were recoded into the bicyclist category. Anyone residing in Kailua was classified as a resident; all others were non-residents. Trip purpose was organized into three categories: utilitarian (e.g., commuting to work, getting food), leisure (e.g., exercise or recreation), or a combination of both. Reasons for route choice were combined into five categories (most direct or convenient, safety or infrastructure, scenic, other, and two or more).

3. Results

3.1. Sign visibility

Of the total 97 signs to be installed community-wide, 70 signs were planned in the beach and town sections where the intercept surveys were conducted. Overall, 66 of those 70 signs (94%) were present as designated by the wayfinding signage plan. Missing signs were still pending manufacture and/or installation. Of the signs observed, four (6%) in the beach section were partially obscured at both time points (one by a utility pole and three by overgrown vegetation primarily originating from private property). In addition, two signs were partially obscured at time of the first wave of data collection while one sign was partially obscured at time of the second wave of data collection. Supplemental File 1 displays a map of the wayfinding signs in the town and beach areas along with findings from the sign audit. No graffiti markings or other occurrences of vandalism were observed on the signs.

3.2. Participants

The final sample consisted of 192 pedestrians (79.7%) and 49 bicyclists (20.3%). Fifty-one surveys (21.2%) were administered in Japanese. Table 1 presents demographic characteristics of the participants, along with trip purpose, reason for using route, and frequency of route use. A higher percentage of bicyclists were surveyed at the beach location. Bicyclists were more likely to be community residents. Pedestrians tended to select the most direct route to their destination, while bicyclists also took safety and

Table 1
Characteristics of survey respondents by active mode of transportation.

	Pedestrian (n = 192)		Bicyclist (n = 49)		p[a]	Overall n = 241	
	n	%	***n***	%		***n***	%
Survey Wave					**0.010**		
Wave 1	77	40.1	10	20.4		87	36.1
Wave 2	115	59.9	39	79.6		154	63.9
Survey Location					**0.020**		
Beach	82	42.7	30	61.2		112	46.5
Town	110	57.3	19	38.8		129	53.5
Gender					0.062		
Male	85	44.3	29	59.2		114	47.3
Female	107	55.7	20	40.8		127	52.7
Age (years)					0.250		
18–25	33	17.2	4	8.2		37	15.4
26–35	62	32.3	14	28.6		76	31.5
36–45	28	14.5	7	14.3		35	14.5
46–55	19	9.9	9	18.4		28	11.6
56–65	25	13.0	6	12.2		31	12.7
66 +	25	13.0	9	18.4		34	14.1
Residency					**0.006**		
Resident	83	43.2	32	65.3		115	47.7
Non-resident	109	56.8	17	34.7		126	52.3
Trip Purpose					0.052		
Utilitarian	85	44.3	14	28.6		99	41.1
Leisure/recreation	88	45.8	32	65.3		120	49.8
Both	19	9.9	3	6.1		22	9.1
Reason for Selecting Route					**0.000**		
Direct	125	65.1	19	38.8		144	59.8
Safety/infrastructure	14	7.3	16	32.7		30	12.5
Scenic	18	9.4	3	6.1		21	8.7
Other	11	5.7	2	4.1		13	5.4
Two or More	24	12.5	9	18.4		33	13.7
Frequency of Route Use					0.126		
First time	74	38.5	12	24.5		86	35.7
Between 2 and 10 times	42	21.9	16	32.7		58	24.1
Over 11 times to Daily	76	39.6	21	42.9		97	40.3
Wayfinding Sign					0.111		
Saw Sign	97	50.5	31	63.3		128	53.1
Did Not See Sign	95	49.5	18	36.7		113	46.9

[a] p-value from χ^2 test.

infrastructure (e.g., presence of bike lanes) into consideration. Notably, only one participant—unprompted by subsequent questions about wayfinding signage—reported that signs were the reason for selecting his/her route. The majority of participants surveyed in the town location started their trip in town (58.9%) or in surrounding neighborhoods (30.3%). In contrast, those surveyed at the beach location started their trip at the beach (35.7%), surrounding neighborhoods (29.5%), and town (28.6%) (comparison not reported in table).

3.3. Seeing and using wayfinding signs

Slightly more than half (53.1%) of the surveyed pedestrians and bicyclists reported seeing a wayfinding sign along their present route. A greater proportion of bicyclists reported seeing a sign, but the difference was not statistically significant. Non-residents tended to be more likely to see a sign. In the logistic regression model, the only variable significantly associated with seeing a wayfinding sign was frequency of route use: 67.4% of participants who were on the route for the first time saw a sign. Table 2 displays the frequencies and associated odds ratios for seeing a sign.

Among those who reported seeing a sign (n = 128), 41.4% said it helped them to choose their route. The logistic regression model found that several variables were significantly associated with using a sign (Table 2). Bicyclists had 4.49 times greater odds compared to pedestrians (95% CI: 1.16–17.32). Non-residents and women were also more likely than men to report using the signs. Additionally, being surveyed in town significantly predicted using signs compared to the beach location.

Participants were asked to explain why the signs did or did not help them choose their route that day. Most residents reported not needing to use signs because of their familiarity with knowing their way around or use of regular routes (e.g., *because I live here, I know where I'm going*). For the residents who did use the signs, they said that it helped direct them to bike lanes or safer routes (e.g., *I use the signs to find the bike route*). Non-residents said that the signs helped them by confirming the way or giving them direction (e.g., *helped me understand the location of the beach*). Japanese visitors (i.e., respondents of the Japanese-language surveys) said signs were easy to understand (e.g., w*e can know the sign without understanding English*). On the other hand, non-residents who did not use the sign

Table 2
Correlates of seeing and using wayfinding signs[a].

	Saw sign $n = 241$		Used sign $n = 128$	
	% (n)	**OR (95% CI)**	**% (n)**	**OR (95% CI)**
Survey Wave				
Wave 1	55.2 (48)	Reference	41.7 (20)	Reference
Wave 2	52.0 (80)	0.79 (0.43–1.46)	41.3 (33)	0.92 (0.35–2.43)
Survey Location				
Beach	51.8 (58)	Reference	32.8 (19)	Reference
Town	54.3 (70)	1.50 (0.81–2.80)	48.6 (34)	**3.71 (1.30–10.58)**
Mode of Transportation				
Pedestrian	50.5 (97)	Reference	41.2 (40)	Reference
Bicyclist	63.3 (31)	1.95 (0.90–4.22)	41.9 (13)	**4.49 (1.16–17.32)**
Gender				
Male	53.5 (61)	Reference	36.1 (22)	Reference
Female	52.8 (67)	1.02 (0.59–1.77)	46.3 (31)	**3.30 (1.18–9.23)**
Age				
18–25	51.4 (19)	0.50 (0.18–1.42)	31.6 (6)	0.58 (0.11–3.03)
26–35	56.6 (43)	0.47 (0.18–1.21)	67.4 (29)	3.05 (0.77–12.04)
36–45	51.4 (18)	0.64 (0.23–1.80)	27.8 (5)	0.66 (0.11–3.89)
46–55	53.6 (15)	0.58 (0.20–1.72)	26.7 (4)	0.56 (0.09–3.53)
56–65	35.5 (11)	0.23 (0.08–0.68)	27.3 (3)	0.69 (0.09–5.32)
66 +	64.7 (22)	Reference	27.3 (6)	Reference
Residency				
Resident	47.0 (54)	Reference	18.5 (10)	Reference
Non-Resident	58.7 (74)	1.12 (0.53–2.37)	58.1 (43)	**6.67 (1.24–35.87)**
Trip Purpose				
Utilitarian	46.5 (46)	Reference	37.0 (17)	Reference
Leisure/recreation	59.2 (71)	1.62 (0.83–3.14)	45.1 (32)	1.10 (0.36–3.40)
Both	50.0 (11)	1.21 (0.44–3.33)	36.4 (4)	1.17 (0.18–7.78)
Reason for Selecting Route				
Direct	52.8 (76)	Reference	43.4 (33)	Reference
Safety/Infrastructure	63.3 (19)	1.44 (0.57–3.67)	31.6 (6)	0.70 (0.16–3.01)
Scenic	47.6 (10)	0.67 (0.25–1.78)	60.0 (6)	2.52 (0.41–15.55)
Other	46.2 (6)	0.90 (0.26–3.20)	16.7 (1)	0.19 (0.01–4.15)
Two or more	51.5 (17)	0.95 (0.42–2.15)	41.2 (7)	0.84 (0.20–3.50)
Frequency of Route Use				
First time	67.4 (58)	**2.59 (1.07–6.27)**	65.5 (38)	1.32 (0.24–7.20)
2–10 times	43.1 (25)	0.76 (0.36–1.60)	20.0 (5)	0.28 (0.05–1.51)
11 + times to Daily	46.4 (45)	Reference	22.2 (10)	Reference

[a] Significant odds ratios are bolded.

said that they used alternative wayfinding tools, such as Google maps/GPS. Another common theme was that pedestrians mentioned that they thought the signs were not relevant to them since they were associated with bicycle symbols (e.g., *we walked so did not notice the signs*).

3.4. Promotion of walking and bicycling

One-third of residents agreed that seeing wayfinding signs encouraged them to walk or bike more often in the community (7.8% strongly agreed and 25.2% agreed). Those who disagreed mentioned that they already walk and bicycle in the community so the signs would not influence their behavior (e.g., *I do it anyway, but it might help others*). When asked what would make it safer to walk or bicycle in the community, participants wanted more/safer infrastructure for walking and bicycling (e.g., traffic calming measures, more visible crosswalk markings, more separated bicycle lanes) and education of drivers and bicyclists on rules of the road. Participants also gave feedback on the wayfinding signs, asking for more signs, larger signs, better placement of signs at eye level, and signs in different languages to help tourists.

3.5. Perceived community benefit

The majority of participants (84.7%) said that wayfinding signs with direction and distance were beneficial to the community. Compared to non-residents, residents were more likely to disagree that wayfinding signs were beneficial to the community; however, only 8.7% of residents felt that signs were not beneficial (Table 3). Qualitative comments indicated that the signs were primarily perceived as beneficial for tourists: *more for visitors, but beneficial so I don't have to give directions*; *prevents wandering or being lost*; *especially benefits outsiders*. Furthermore, 83.4% of participants said that similar wayfinding signs would be helpful in other communities in Hawai‘i. In particular, participants said that signs would be helpful in the city's urban core, in communities with a high proportion of tourists (Waikiki, North Shore), and in communities with existing walking/bicycling infrastructure.

Table 3
Perceived community benefit of wayfinding signs. *Are wayfinding signs with direction and distance beneficial to the community?*[a]

(%)	**Resident** (n = 115)	**Non-resident** (n = 126)
Yes	82.6	86.5
No	8.7	0.8
Not sure	8.7	12.7

[a] χ^2 (2) = 9.23, p = 0.01.

4. Discussion

This evaluation study confirms that wayfinding signs are most useful to those who are new to the area and need help navigating from place to place. Residents were more likely to be traveling along familiar routes and did not require wayfinding support. Given that most wayfinding signs were associated with bicycle route signs, it was somewhat expected that signs were more likely to be used by bicyclists than pedestrians. The mounting height of signs—in accordance with bicycle, rather than pedestrian-oriented, guidelines—also may have contributed to pedestrians being slightly less likely to see a wayfinding sign. However, approximately half of pedestrians noticed the wayfinding signs, suggesting potential utility if pedestrians perceived themselves as intended users.

The evaluation results also indicate some support for encouraging walking and bicycling in the community among residents, but selection bias should be taken into consideration. Participants were already walking and bicycling in the community and indicated that their level of activity would likely stay the same. We were unable to determine if the wayfinding signs influenced any residents who do not currently engage in active transportation to get around the community. Future studies also should assess whether wayfinding signs influence physical activity behavior by replacing car trips with walking or bicycling. Finally, there was overall support for the wayfinding signage project from our participants, especially as it pertained to addressing the needs of visitors to the community.

4.1. Implications for practice

As an evaluation approach, intercept surveys were a suitable way of collecting feedback from the intended target population (i.e., pedestrians and bicyclists). Compared to telephone surveys, intercept surveys may be better at obtaining a representative sample within a specific geographic area (King et al., 2010). The intercept surveys gleaned valuable insights of how wayfinding signs were perceived. For example, tourists from Japan reported that signs were easy to understand while residents believed that signs had to be in multiple languages to be useful to tourists. The common perception among residents that signs were intended primarily for tourists also indicates that additional educational programs or promotional activities (e.g., social marketing campaigns) should be considered to increase awareness of how signs could serve as environmental prompts for residents to walk and bicycle to community destinations instead of driving. By indicating routes to active living destinations such as public parks and beaches, the wayfinding signs could be a component of a multi-level community intervention to promote physical activity among less physically active residents.

We have several recommendations for others who are planning to evaluate the effectiveness of wayfinding interventions. First, we did not anticipate all of the qualitative feedback that participants provided as they were answering the survey questions. Because the intercept survey was administered verbally, many participants provided accompanying explanations for their survey responses, including the questions with closed-ended response options. We did our best to record all of their verbal feedback, but it was difficult for the survey administrator to record it verbatim. We recommend preparing data collectors to better capture the qualitative feedback that participants provide to explain their answers.

A second recommendation is to incorporate a process evaluation component into the evaluation design. For this demonstration project, partners learned valuable lessons about implementation of wayfinding signs. As an example, the project was significantly delayed when the transportation agency became aware of evidence of Native Hawaiian burial sites (*iwi*, or ancestral bones) in the planned area. To abide by historic preservation laws that relate to disturbing the ground where *iwi* are found, the transportation agency decided to not to install any signs in locations that would require new sign posts. Thus, the signage plan had to be modified to consist of sign installation that would only be on existing sign posts—and often at heights that were less desirable from the perspective of being seen by people passing by on foot or bicycle. Systematically documenting project barriers and solutions would have been beneficial to inform future wayfinding signage projects.

Process evaluation would also assist with determining intervention cost and other factors influencing adoption (King et al., 2010). For this project, the approximate cost for manufacturing and installing the wayfinding signs (on existing sign posts) was $320 per sign. However, this cost estimate does not take into account the significant time and effort required to develop the wayfinding basis of design and signage plan, the project management costs, or the costs associated with conducting the evaluation study. Future wayfinding evaluation studies should better track intervention costs and assess the cost effectiveness of wayfinding signage interventions.

These evaluation results are specific to the type of wayfinding signs, which were primarily associated with bike signage (Fig. 1). Pedestrians may have benefitted from additional wayfinding support at a pedestrian scale. Project partners initially explored the possibility of installing pedestrian-oriented maps in the commercial town center to complement the bicycle wayfinding signage. However, efforts to design and install pedestrian-oriented maps in the town center did not make any headway during the project period.

4.2. Challenges and limitations

This evaluation study faced challenges similar to other evaluations of built environment interventions, particularly the lack of control over how the intervention is implemented, limited resources to expand the study design and collect data, and difficulty linking environmental changes with impacts on behavior (Adams and Cavill, 2015). If more resources were available, the evaluation study would have been strengthened by incorporating other sources of data, such as motor vehicle crash data for pedestrian and bicyclist incidents. The sample size was relatively small, thus lacking the power to detect potential associations. For example, we did not find changes in using signs or community support between survey waves. We also could not estimate exposure to signs based on the participant's origin and where the intercept survey was conducted; additional route information would be needed to ascertain if participants were exposed to any wayfinding signs that could potentially influence route choices.

Another major limitation of this study is that the findings may not be generalizable to other communities. Compared to the rest of the state, the community selected for the wayfinding signage demonstration project has a higher proportion of white residents (45.7%; 25.7% state) and a greater median household income ($109,087; $71,977 state) (U.S. Census Bureau, 2017). Residents also tend to be more physically active than the state average, as reflected by census-tract level data on leisure time physical activity (Centers for Disease Control and Prevention, 2017). Moreover, study participants were already walking and bicycling in the community. Thus, as previously stated, the findings reflect a selection bias and may not be generalizable to the community residents who do not walk or ride a bicycle. Future studies should be undertaken to understand the usefulness and limitations of wayfinding signage interventions for those who do not currently engage in active transportation. Wayfinding signs are also being installed in more urban areas of Oʻahu, representing an opportunity to study their utility in different settings.

4.3. Conclusions

Wayfinding signage interventions are heterogeneous, and more research is needed to understand what types of wayfinding systems work best to encourage walking and bicycling. To our knowledge, this is the first study to report the perceptions of pedestrians and bicyclists on standard bicycle route guide and destination signs. These types of wayfinding signs are readily transferrable to other communities, and the findings of this evaluation study support their utility, especially for communities with a high proportion of visitors. Residents perceive the wayfinding signs to be beneficial to their community, but additional programs or promotions tied to the wayfinding signs are needed to encourage residents to use active modes of transportation for short trips around their community.

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Conflict of interest

None.

Appendix A. Supplementary material

Supplementary data associated with this article can be found in the online version at https://doi.org/10.1016/j.jth.2018.09.008.

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