

Physical Activity and Transit Survey Device Follow-up Study: Methodology Report

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Background and Study Objectives

Physically active adults have lower rates of various chronic diseases and have lower rates of premature death, and physical activity -- along with change in diet -- can also prevent obesity.¹ Public health surveillance of physical activity (PA) has generally relied on self-report. Precise measurement instruments are needed to better understand the link between physical activity (PA) and health outcomes in epidemiology studies, to track PA through surveillance, and to evaluate interventions to increase PA. In general, self-reported In 2010-2011, the New York City Department of Health and Mental Hygiene (DOHMH) conducted the Physical Activity and Transit (PAT) study, a disproportionately-stratified telephone survey on physical activity and health-related conditions. In 2011, additional funding was available to conduct a follow-up that included objective measures of the intensity and location of PA via accelerometer and Global Positioning System (GPS) devices.

The primary objective of the device follow-up study was to provide an estimate of PA among NYC adults. Secondary objectives included:

- Mapping the location of physical activity to explore the relationship between the built environment and PA;
- Determining levels of activity by mode of travel;
- Comparing self-reported and objectively measured activity levels to gain insight into the relationship between these two assessment tools; and
- Developing a better understanding of what motivates people to be physically active, including opportunities for physical activity and its relationship to the built environment.

¹ U.S. Department of Health and Human Services. The Surgeon General's Vision for a Healthy and Fit Nation.

New York City Department of Health and Mental Hygiene



Rockville, MD: U.S. Department of Health and Human Services, Office of the Surgeon General, January 2010.

Overview of Methodology

The 2011 PAT was a Random Digit Dialing (RDD) telephone survey of approximately 2,500 adults designed to provide estimates of physical activity at the city, borough, and subgroup levels. The PAT used an overlapping landline and cell phone sample frame to contact adults in residential households in New York City, with disproportionate (equal-sized) samples from the five boroughs and oversampling in areas with higher levels of obesity. (The sample frame excludes adults living in institutional or group housing. Households without either a landline telephone or cell phones are also not included in the sample frame, although weighting adjustments are made to account for this.) The 2011 PAT interview was approximately 25 minutes long -- covering multiple aspects of physical activity, as well as select health conditions and behaviors -- with interviews conducted in English, Spanish, Russian, and Chinese. (The full questionnaire is in the Study Materials section.) All 2011 PAT interviews were completed between March 22 and November 27, 2011, and conducted by Abt SRBI (New York, NY) from call centers in New York City, New Jersey, and Florida.

Once the 2011 PAT survey was completed, mobile respondents (those who could walk more than 10 feet) were provided with a description of the device follow-up study and asked if they would be willing to participate. Device participants were asked to wear both an accelerometer device and a GPS device during all waking hours for one week. Those who agreed provided their name, contact information, and mailing address for the devices. The two devices and materials (including an elastic belt for wearing the accelerometer and a charger for the GPS unit) were sent via United States Postal Service Priority Mail or FedEx, as needed or desired. Because contact with participants was only via telephone, the package also included user-friendly instructions on when and how to wear the devices, how to re-charge the GPS unit nightly, and how to return the devices. (see Project Materials in the Appendix). Participants were asked to start wearing the two devices for a period of 7 days, starting on the Thursday of the week the package was received.

During this time, participants completed an activity log to indicate when they removed the device during the day (e.g., while bathing) or engaged in physical activity that is difficult to measure by accelerometer (e.g., bicycling or swimming). After wearing the devices for up to seven days, participants returned the devices using a postage-paid envelope and were then sent a check for their participation. (The amount of the check was determined solely by the number of days respondents reported wearing their accelerometer for at least 8 hours). When needed, calls were made and/or letters sent to encourage the return of the devices. In an effort to maximize the collection of activity data, contacted respondents who had not worn the devices were encouraged to wear at just the accelerometer for a week and not worry about wearing the GPS device.

The design of the Device Follow-Up had the merits of efficiency in contacting and recruiting participants (by using the 2011 PAT). Among other things, it also provided an opportunity to compare self-reported activity measures from the telephone survey PAT with objective data from the accelerometers.

Project Team and Study Timeline

Within the DOHMH, both the PAT Survey and the Device Follow-up were led by the Bureau of Epidemiology Services Survey Unit, supported by the Bureau of Chronic Disease and Prevention and Control CVD Prevention and Control Program. Together, these programs developed study materials including a questionnaire, recruitment scripts, a frequently-asked questions sheet (FAQs), a detailed instruction book, and consent forms. These materials can be found in the Study Materials section of this report.

Abt-SRBI, a national survey research organization, was contracted to collect data for both studies, including telephone surveys, device management, and downloading of device data. Abt-SRBI also coordinated work done by sub-contractor GeoStats (Atlanta, GA). GeoStats cleaned and processed the accelerometer and GPS data and provided the DOHMH with final data sets for both devices. Andrew Rundle at the Columbia University's Mailman School of Public Health was contracted to analyze the relationship between activity measured by accelerometers and features of the built environment (proximity to parks, sidewalks, retail and population density, etc.).

Other experts provided invaluable assistance in the design, direction, and analysis of the study's data. Our thanks goes to James McClain, PhD, MPH and Richard Troiano, PhD (both at the National Cancer Institute); James Sallis, PhD (University of California San Diego); and Stewart Trost, PhD (Oregon State University College of Public Health and Human Sciences).

Recruitment for the Device Follow-up started with the PAT survey in March 22, 2011 and concluded November 26, 2011. Devices returned to Abt SRBI by January 18, 2012 were included in the final data set.

Sample Design and Sample Size

Data collection for the PAT Survey and Device Follow-up Study was distributed over 9 months to reduce seasonal effects on physical activity². Sample size for the study was determined by the likely number of 2011 PAT survey respondents who would participate in the Device Follow-up. The pre-survey goal was to collect accelerometer and GPS data from 800 of approximately 2600 PAT survey respondents.

The 2011 PAT used an overlapping dual frame telephone sample design. The first sampling frame contained telephone numbers in New York City landline telephone exchange 100-banks

² CDC. 1997. Monthly estimates of leisure-time physical inactivity: United States, 1994. *MMWR Morb Mortal Wkly Rep* 46:393-397

with one or more directory-listed residential telephone numbers, which was supplemented with telephone numbers from New York City Cablevision exchange 100-banks with zero directory-listed residential telephone numbers within 1000-banks with one or more directory-listed residential telephone numbers (Cablevision zero banks). The landline sample included two components: equal-sized samples from each of the five boroughs of NYC, plus oversamples of areas with high rates of obesity in the South Bronx and Manhattan, Brooklyn, Queens, and Staten Island.

The second sampling frame consisted of telephone numbers located in 100-banks in cellular telephone exchanges that covered New York City. The design is overlapping because in the sample from the cellular frame, interviews were completed with cell phone-only adults as well as adults living in households with landline telephones (dual users). Sample telephone numbers from the landline sample that were identified as cellular telephone numbers were moved to the cellular sample for dialing.

Accelerometer and GPS devices

All participants wore an ActiGraph GT3X accelerometer (ActiGraph, Pensacola, FL 32502), designed to be worn on the waist, and set to record average activity every 10 seconds ("epochs"). The manufacturer's list price was \$335 per device.

Location data was recorded using a GlobalSat DG-100 GPS Data Logger (USGlobalSat, Inc., Chino, CA), worn clipped to a belt or carried in a bag or backpack. These units were set to record location every 5 seconds. However, data was rarely available for every 5 second period due to loss of signal from GPS positioning satellites, e.g., being inside a building, or in "digital canyons" where tall buildings can prevent the data logger from receiving GPS satellite signals, or being entirely out of reach of satellite signals (e.g., in a subway tunnel). Unlike the GT3X, which can collect data for several weeks on a single charge, the rechargeable batteries in the GPS unit typically last 22-24 hours: participants needed to recharge the device every evening with a supplied charger. The manufacturer's list price for the DG-100 was \$88.86 per unit.

Figure 1: Actigraph GT3X Accelerometer (left) and GlobalSat DG-100 GPS Data Logger (right)

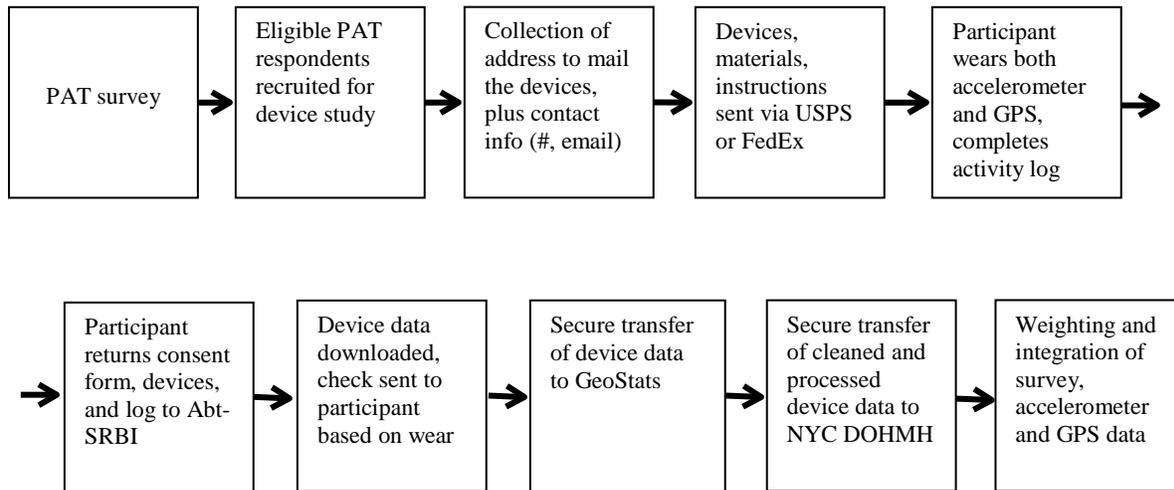


Pilot Test of the Device Follow-up Study

BES staff conducted in-house pilot tests of both accelerometer and GPS to test the downloading of data from both types of devices. Project staff conducted cognitive pretesting of the study materials with other DOHMH employees unconnected to the project, and made minor changes to the layout and terminology used in the instructional materials (see Study Materials) developed for the Device Follow-up. The protocol, materials, devices etc. were also pilot tested with 50 participants recruited from the 2010 PAT survey. The 2011 PAT survey instrument was nearly identical to that used by the 2010 PAT. Cognitive testing was used to refine a small number of questions added to the 2011 PAT.

Data Collection Protocol: Accelerometer and GPS Devices

Figure 2: Flow diagram of the overall study process.



Eligibility and Recruitment

From the 2,611 NYC adults interviewed for the 2011 PAT survey, 2,488 were able to walk more than 10 feet and thus eligible for the Device Follow-up Study. At the conclusion of the PAT survey, these respondents were read the following:

Now I'd like to mention a follow-up study the Health Department is conducting on physical activity and travel that offers \$100 for participation.

For this study, the Health Department wants to measure how much activity New Yorkers get in a typical week as they go about their daily activities - such as commuting, running errands, or exercising. We would send you an activity monitor and a GPS device to wear for seven days. The activity monitor is a small, light-weight device worn on an elastic belt around your waist. The GPS is a small device you can clip to your waistband or a bag. The devices measure the location and level of activity you get in a typical week. You would just need to wear the devices for seven days, then send them back to us. You should not change your normal activities.

Can I confirm that you will participate in this follow-up study?

Those who agreed to participate were then asked to provide a mailing address for the devices and additional contact information (e.g., telephone number, email address) and to identify a one-

week period to wear the devices, starting on a Thursday. They were given a call on the day the devices were to be delivered reminding them to start wearing the devices on Thursday, and called again over the weekend to encourage them to continue or start wearing the devices.

For a comparison of the unweighted demographics of Device Follow-up participants with non-participating PAT survey respondents, see Table 1.

Device Follow-up Kit Sent to Participants

Devices were sent by Abt-SRBI via USPS or FedEx, depending on preference and/or address. (FedEx does not deliver to post office boxes.) (For the complete contents of the kit, see Appendix B.)

The device kits included all of the items needed to collect 7 days of activity data using both the accelerometer and GPS, along with instructions on how to position the devices for wear, when to start wearing them, and how to re-charge the GPS unit nightly. Abt-SRBI also set up a toll-free telephone helpline for respondents to use if they had additional questions or problems with the devices, and provided links to a [YouTube](#) video demonstrating device wear and recharging.

Other important components of the kit:

- a research **consent form** requiring the participant's signature to participate in the study. Only devices with a signed consent form were included in the final data set.
- an **activity log** on which participants were instructed to write down the time the first put on and last removed the device and if they stayed indoors or were sick, or if they engaged in activity that is either poorly measured by accelerometer (e.g., bike riding) and can't be measured at all (e.g., swimming, as the GT3X is not waterproof).
- a **postage-paid box** was provided for returning the devices and activity log to Abt-SRBI.

Wearing the Devices

Participants were instructed to start wearing both devices on the Thursday they had selected when they were recruited, and the accelerometers were initialized to automatically begin recording at midnight of the designed Thursday. (Not all participants started wearing the devices that day. Those who started wearing the device before the designated Thursday or who wore the devices for more than 7 days were included in the data set, but only the first 7 full days of wear starting on the Thursday were used, no matter how many days the devices were worn.) The first day of accelerometer data was typically two weeks after the PAT survey.

Participants were asked to put on the accelerometer first thing in the morning and wear it until they go to bed (although not to wear it in the shower). They were also instructed to charge the GPS device nightly.

Based on the logs returned with the devices, individuals who wore the accelerometer for 3 - 7 days were given a check for \$100, those who provided 1-2 days of wear time were paid \$20 and everyone else was paid \$10 for returning the devices.

Device loss was minimal. Of the 1,134 device/kit mailings, only 76 (6.7%) resulted in device loss. Multiple efforts were made to retrieve devices as well as reduce study nonresponse. Calls were made to respondents who did not return the devices to encourage them to return the devices if they had worn them, or to wear just the accelerometer for 7 days before returning the unit. Finally, letters were sent offering a \$50 gift card for sending back the devices.

Processing and Cleaning of Device Data

Once devices were returned with a signed consent form, Abt-SRBI downloaded the data and sent incentive checks to participants based on the number of days on which the devices were worn for 8 or more hours, as recorded on the activity log. Device data was then transmitted weekly to GeoStats over a secured network for processing and cleaning.

Accelerometer data

Although the GT3X is a tri-axial device, only the vertical axis was used for analysis, consistent with many other studies of physical activity using accelerometer, including the 2003-2006 National Health Nutrition Examination Survey (NHANES). Accelerometer data was also processed with the same protocols used by the NHANES.³ Non-wear time was identified as accelerometer counts of zero for 60 consecutive minutes or longer, allowing for one to two consecutive minutes of counts between 1 and 100. Participants who provided four or more days of valid wear (10 hours of wear time using NHANES definitions) were included in the analytic data set. Minutes of activity with fewer than 100 activity counts were classified as Sedentary, minutes with 100-2019 were classified as Light, 2020 - 5998 were classified as Moderate activity minutes, and 5999 or more were classified as Vigorous activity minutes. Of the 679 who wore their accelerometer for four or more days, 237 wore the accelerometer for at least seven full days.

GPS data

GeoStats was responsible for processing the GPS data. This included identifying and suppressing improbable GPS coordinates based on a combination of location, distance, time, and speed thresholds. GPS points logged while traveling were matched to transportation network data (link-matching) to impute the modes of transportation used. GeoStats also geo-coded the home and work locations of participants by selecting the dominant location derived from GPS data or, when GPS data was not available, through respondent-reported street intersection data.

³ Troiano, RP, D Berrigan, KW Dodd, LC Masse, T Tilert, and M McDowell. 2008. Physical Activity in the United States Measured by Accelerometer. *Med Sci Sports Exerc* 40(1): 181-188.

Quality Control, Data Integration and Processing

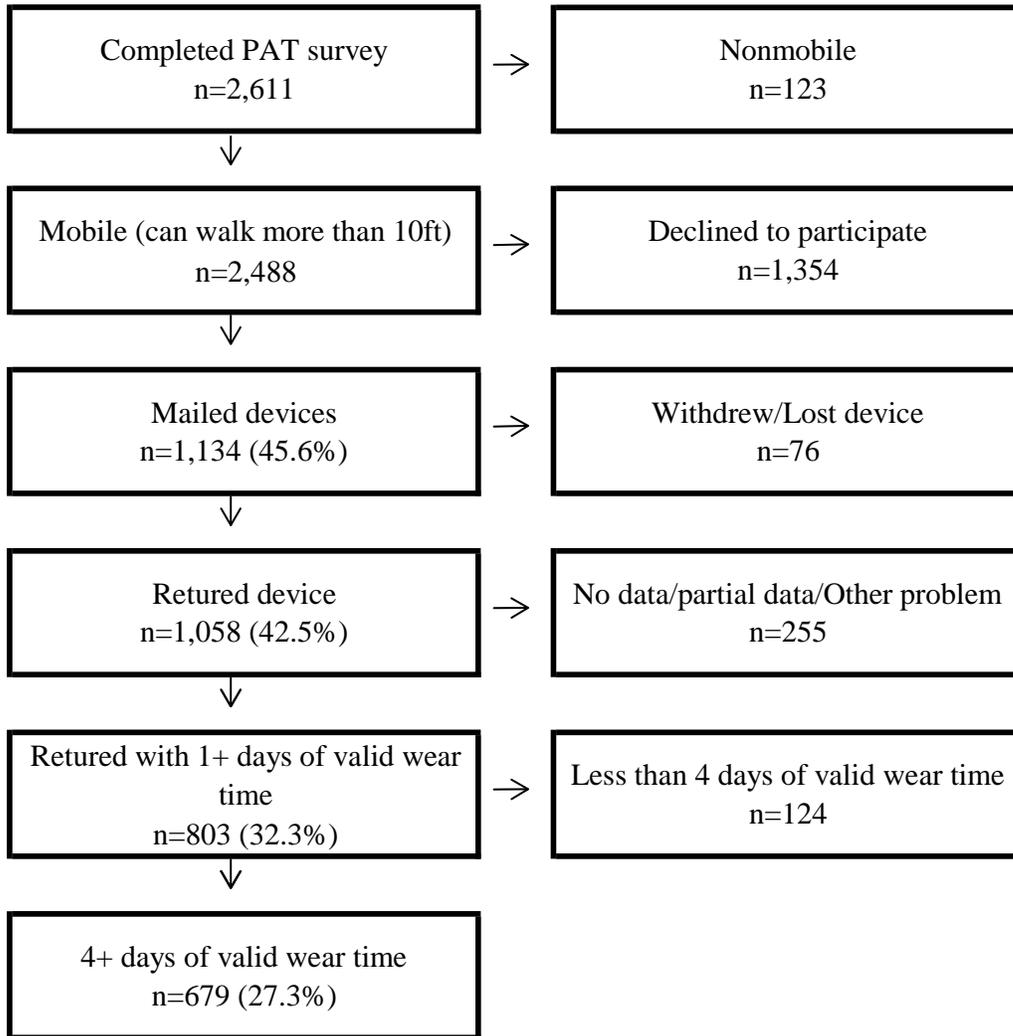
Quality Control

To help assure data quality and assess achievement of recruitment targets, data collection for the PAT and Device Follow-up were both closely monitored. DOHMH staff reviewed weekly reports from Abt SRBI on the number of PAT interviews, recruitment into the Device Follow-up, the scheduling of device mailing, rates of return and data completeness. In addition to monitoring by field supervisors at Abt SRBI, PAT interviews were monitored remotely by DOHMH staff to assure that survey data collection protocols were followed.

Processing of the data occurred throughout data collection and involved several components, including the development of SAS code for cleaning and recoding the data (based on preliminary data sets posted to a DOHMH secure ftp site), and implementation of other checks for consistency once the full accelerometer and GPS data sets were available. A unique identifier that was assigned to participants at recruitment was used to merge accelerometer and GPS data with PAT survey data.

Device Follow-up Participation Diagram

Figure 3: Study participation from PAT survey to Device Follow-up completion



Calculation of Study Participation Rates

The Device Follow-up required participation in two phases. In the first phase, the PAT interview was administered to a randomly selected adult contacted by either landline or cellular telephone. In the second phase eligible adults were asked to participate in the Device Follow-up, mailed an accelerometer and GPS unit, wore the devices, and then returned them. The final response rate for the Device Follow-up is the product of these two phases.⁴

Using AAPOR Response Rate RR#3⁵, which assumes the portion of eligible numbers among those with unknown eligibility is the same as the portion of eligible numbers among those with known eligibility, the combined landline and cellular telephone rate for the 2011 PAT survey was 33.7%. Using AAPOR Cooperation Rate CR#3⁴, the cooperation rate for the combined sample was 92.0%.

Participation in the Device Follow-up required that the adult interviewed for the PAT be able to walk more than 10 feet. Of the 2488 adults who completed the PAT interview and were mobile (i.e., eligible), 803 provided one or more days of valid accelerometer data, yielding a participation rate of 32.3% for this phase of the study. The primary analytic data set was limited to the 679 participants who provided four or more days of accelerometer data (27.3% of eligible PAT respondents).

Participant Demographics

The below Table presents unweighted demographic frequencies for the 2,488 adults who completed the 2011 PAT survey. There were relatively few demographic differences between those who provided at least 4 days of accelerometer data with 10 hours of wear time and those who did not (either because they declined to participate in the Device Follow-up or because they participated but provided less than 4 days of data.) Four-day Device Follow-up completion was less common among Asians and those with less than a High School education.

⁴ For the two phases of data collection, the overall response rate is the product of the PAT survey and the Device Follow-up responses rates, calculated as detailed above. The overall response rate for the two phases of data collection is $33.7\% * 32.3\% = 10.9\%$.

⁵ The American Association for Public Opinion Research. 2011. Standard Definitions: Final Dispositions of Case Codes and Outcome Rates for Surveys. 7th edition. AAPOR. <http://aapor.org/Content/NavigationMenu/AboutAAPOR/StandardsampEthics/StandardDefinitions/StandardDefinitions2011.pdf>

Table 1: Unweighted demographics of Mobile 2011 PAT respondents, comparing those who provided 4 or more 10-hour days of wear time to those who either declined to participate or provided less than 4 days of data.

	Total mobile 2011 PAT respondents	Completed 4+ days of Device Follow-up	Declined / Less than 4 days	Compled 4+ days % of Total
Total	2488	679	1809	27.3%
Sex				
Male	1001	267	734	26.7%
Female	1487	412	1075	27.7%
Race				
White	1088	300	790	27.6%
Black	609	182	434	29.9%
Hispanic	527	152	383	28.8%
Asian	191	32	166	16.8%
Other	73	13	36	17.8%
Age				
18-24	178	40	140	22.5%
25-44	719	221	514	30.7%
45-64	926	284	665	30.7%
65+	598	133	487	22.2%
Income				
Below 100% Poverty	417	104	349	24.9%
100%-200% Poverty	385	114	271	29.6%
200-700+ % Poverty	1288	400	897	31.1%
Missing/Refused	398	61	292	15.3%
Weight Status				
Healthy weight	901	251	683	27.9%
Over weight	857	235	637	27.4%
Obese	629	184	450	29.3%
Borough				
Bronx	432	128	304	29.6%
Brooklyn	526	141	385	26.8%
Manhattan	465	120	345	25.8%
Queens	614	154	460	25.1%
Staten Island	451	136	315	30.2%
Employment Status				
Employed	1319	404	915	30.6%
Unemployed	217	60	157	27.6%
Not in Labor Force	947	213	734	22.5%
Foreign born				
No	1579	468	1111	29.6%
Yes	908	211	697	23.2%
Education				
Less than High Scho	317	58	259	18.3%
High School Degree	610	155	455	25.4%
Some College	517	157	360	30.4%
College+	1034	308	726	29.8%

Post-survey Weighting

The 679 accelerometer Device Follow-up cases were weighted to match the population figures for the PAT survey respondents (based on the 2006-2008 American Community Survey), starting with each case's final weight for the 2011 PAT. To adjust for differential participation in the Device Follow-up, raking was also done to two additional dimensions: response propensity and level of activity from self-report.

Response propensity

A binary logistic regression model was created to predict the probability that a survey respondent would provide valid accelerometer data, using 21 independent variables. Cases were then ranked by predicted probability into quintiles and included as a weighting dimension. This ensured that the weighted accelerometer sample would have equal numbers from each of the propensity quintiles, e.g., cases from the 20% least likely to provide 4 or more days of accelerometer data accounted for 20% of the weighted accelerometer data.

Level of activity from self-report

Even after adjusting for response propensity, it was observed that those who wore an accelerometer for four or more days were generally more active than those who did not. Survey respondents were ranked by minutes of self-reported weekly activity from the Global Physical Activity Questionnaire (GPAQ) questions in the PAT. Accelerometer cases were then weighted to match the quintiles of activity reported in the survey (e.g., the least active 20% of cases by self-report were also 20% of the weighted cases with accelerometer data). Note: this is not a modification or weighting of activity as recorded by accelerometer, just a weighting of the cases that provided accelerometer data.

Study Materials

These study materials and appendices provide a list of all documents for the Device Follow-up with hyperlinks to the materials.

Questionnaires, recruitment script

1. [2011 PAT Questionnaire \(ENGLISH\)](#)
2. [2011 PAT Device Follow-Up Recruitment Script](#)
3. [2011 PAT Device Follow-Up FAQ](#)

Device Follow-up materials sent to recruited participants:

- [Introduction letter](#)
- [Instruction sheet](#)
- Accelerometer (red Activity Monitor)
- Black elastic belt (attached to red Activity Monitor)
- Scissors to trim the elastic belt
- Black and silver GPS device with Cable and Charger
- [Consent Forms](#) [2 copies: one for participant to sign and return, one for participant to keep]
- [Activity Log](#) to be completed on days participating, whether or not the devices were worn
- [Frequently Asked Questions \(FAQs\) and answers](#)
- [Study Identification postcard](#)
- Envelope with pre-paid postage to return the devices and signed Consent Form