**Supplemental Digital Content 3.** Technical Description of Score Development

To generate the score, the relationship between physical behavior and survival for each component was first modeled separately using the Generalized Additive Model (GAM) of Hastie and Tibshirani (1990). Denote as a binary indicator of survival of the subject until the end of the study, as a vector containing the individual’s 8 physical behavior measurements, and as the vector containing the individual’s covariates. The GAM relates the predictor vectors and to the mean of the response through

where is the link function, each is an unknown smooth function, is a

vector of unknown parameters, and c is an unknown intercept term. We use the logit link function in our analysis, and note that the outcome of interest for this model is survival, not death, in (1).

The expected relationship between each physical behavior and mortality­ — the functions, , in (S.1) — can be restricted to be consistent with previous studies. In the statistics literature, these restrictions are referred to as shape constraints. The dose-response relationship between aerobic activity and survival has been well characterized as a concave and increasing. (1) Sedentary time was modeled as concave and decreasing and hours of sleep was modeled as concave.(3, 10, 14) To incorporate this information into the models we used the Shape Constrained Additive Regression (SCAR) method of Chen and Samworth (2015) for fitting GAM’s with shape constraints. (SCAR package; <https://cran.r-project.org/web/packages/scar/index.html>).

The fitted values, as they are reported by SCAR, represent the logits of the effect of each physical behavior on survival. Supplemental Figure 2 shows a plot of the fitted values. This is not a scale that is desirable to work with. The regression results should be scaled to be between 0 and 100 to put it on the same scale as scores from other fields, such as the Healthy Eating Index (Guenther et al. 2008). Fitted values from (S.1) indicating a low probability of survival should be translated to values near 0. Fitted values indicating a high probability of survival should be translated to a value near 100.

Time spent sitting adversely impacts survival and fitted values for sitting variables are negative. Since one of the aims of this analysis is to create a score which ranges from 0 to 100, a number lower than 0 is undesirable. In the scoring system we develop, a person with a score of 0 should be getting no positive benefits from physical activity, and a score below 0 has no meaning. Fitted values were rescaled to force the functions to take on only positive values. Denote the scaled function by and the index of the function corresponding to TV sitting as j = A and the index for non-TV sitting as j = B. Both function, and , are rescaled by adding the absolute value of the minimum of both functions. That is,

for j = A, B. The smallest value fitted value of the functions and is 0 after applying (S.2).

Additionally, the estimated function for hours of sleep becomes negative for values greater than about 9.5 hours of sleep. Instead of shifting the function by a constant — such as for the sitting functions — negative values are set to 0, so that

where is an indicator function. This function takes on value 1 if is positive and 0 if is negative.

For simple notation, all shape constrained functions are referred to by even if they have not been modified as in (S.2) and (S.3). As a final step, the maximum values of each is calculated and then summed. Denote this quantity as T. Formally,

The fitted values for every subject in the dataset are then divided by T. This is the Physical Behavior Score reported in the paper. The result is denoted by S, i.e.,

At this stage, S is between 0 and 100 for every individual in the NIH-AARP dataset. A plot of the rescaled functions are given in Figure 1 and the distribution of physical behavior scores is given in Supplemental Figure 2.