Types of manuscript: short review

The manuscript is submitted to the special issue “Physical Fitness Matter: epidemiology & measurement.

Title

Japanese physical fitness surveillance: A greater need for international publications that utilize the world’s best physical fitness database

Authors:
Tetsuhiro Kidokoro¹,²*, Grant R. Tomkinson³,⁴, Shingo Noi¹, Koya Suzuki²†

Affiliations:
¹Research Institute for Health and Sport Science, Nippon Sport Science University, Tokyo, Japan
²Graduate School of Health and Sports Science, Juntendo University, Chiba, Japan
³Department of Education, Health and Behavior Studies, University of North Dakota, Grand Forks, ND, USA
⁴Alliance for Research in Exercise, Nutrition and Activity (ARENA), Allied Health and Human Performance, University of South Australia, Adelaide, SA, Australia

Corresponding:
*Correspondence: kidokoro@nittai.ac.jp; ko-suzuki@juntendo.ac.jp
†Tetsuhiro Kidokoro and Koya Suzuki contributed equally to this work.

Dr. Tetsuhiro Kidokoro
Research Institute for Health and Sport Science, Nippon Sport Science University
7-1-1, Fukasawa, Setagaya, Tokyo, 158-8508, Japan
Email: kidokoro@nittai.ac.jp
Tel: +81-3-5706-0992

Dr. Koya Suzuki
Graduate School of Health and Sports Science, Juntendo University, 1-1Hirakagakuendai, Inzai, Chiba, Japan
Email: ko-suzuki@juntendo.ac.jp
Running title: Japanese physical fitness surveillance

2554 words

Abbreviations:
Abstract

Physical fitness (PF) is significantly associated with current and future health. Routine assessment of PF is important not only to understand the overall health of the population, but also to predict future disease burden. While the annual national PF testing conducted by the Japan Sports Agency is well known domestically, the existence of this surveillance strategy is seldom recognized internationally as only a few published studies have used this PF surveillance dataset. This short review has three aims. First, we briefly summarize the history and test battery of the annual national PF surveillance system for Japanese people. Second, we discuss published research, including our recent work that utilized data from the Japanese PF surveillance database. Third, we propose a priority research agenda for Japanese PF surveillance. While annual PF surveillance appears to be “normal” for Japan, such surveillance efforts are extremely rare internationally. Promoting international publications using Japan’s national PF surveillance dataset provides an important opportunity for other countries to develop similar cost-effective public health surveillance strategies.

167/250 words

Key words: monitor, physical activity, public health, population
題目
日本の体力サーベイランス：世界最高水準の体力データベースを用いた国際論文の必要性

著者
城所哲宏1, グラント R トムキンソン2,3, 野井真吾1, 鈴木宏哉4

所属
1 日本体育大学体育研究所
2 Department of Education, Health and Behavior Studies, University of North Dakota,
3 Alliance for Research in Exercise, Nutrition and Activity (ARENA), Allied Health and Human Performance, University of South Australia
4 順天堂大学大学院スポーツ健康科学研究科

連絡先
城所哲宏
日本体育大学体育研究所
〒158-8508 東京都世田谷区深沢 7-1-1
抄録
体力は現在および将来の健康と密接に関連している。したがって、定期的な体力測定は、現在の健康状態を把握するだけでなく、将来の健康リスクを予測するためにも重要である。国内では、スポーツ庁が毎年実施している体力テストが有名であるが、この体力テストのデータを用いて国際誌に掲載された論文は非常に限られており、国外ではほとんど知られていない。本レビュー論文には3つの目的がある。1つ目は、日本の体力テストの歴史やテスト項目を概説することである。2つ目は、日本の体力テストのデータセットを用いて国際誌に掲載された論文を紹介することである。ここでは、我々の最新の研究成果も紹介する。3つ
目は、日本の体力テストに関する研究の展望を述べる。我が国では、全国規模の体力テストが毎年実施されるは「普通」であるが、国際的にはこのような体力テストは極めて稀である。日本の体力テストのデータを使った国際論文を進めることは重要であり、このことにより、他国でも同様なサーベイランスが行われることが期待される。
1. Introduction

As physical fitness (PF) is significantly associated with current and future health in both children and adults, routine assessment of PF is important not only for monitoring the health of the population but also for predicting future disease burden. More recently, there has been increasing interest in the utility of field-based PF tests for population health surveillance. Some field-based PF tests, including those assessing cardiorespiratory fitness and muscular fitness, could be effective for public health surveillance because they are acceptable, feasible, and scalable measures that have excellent health-related predictive validity.

The Japanese government has been conducting annual national PF surveillance since 1964, when the first Tokyo Summer Olympics was held. While there have been several changes in the sampling strategy and the PF test battery over the years (for more detail, see Section 2), Japan has accumulated more than 50 years of annual national PF data. While annual PF testing is normal in Japan, such is not the case internationally. To the best of our knowledge, no other country has a comparable history of continuous national annual PF surveillance to Japan. However, because only a few studies using this PF surveillance dataset have been published in international peer-reviewed scientific journals, Japan’s fitness surveillance system is largely unknown overseas. Thus, promoting
international publications using the national PF surveillance dataset provides a potential
opportunity for other countries to engage in a similar public health surveillance strategy.

This short review was performed with three main objectives. First, we aimed to briefly
summarize the history and test protocols used for Japan’s annual national PF surveillance
system. Second, we aimed to discuss published research, including our recent work,
which have used data from the PF surveillance database. Third, we propose a priority
research agenda for Japanese PF surveillance.

2. Japanese PF surveillance

2.1 Brief history of Japanese PF surveillance

Survey on Physical Fitness and Motor Abilities (hereafter referred to as the “JP Fit Survey
for All Ages”) has been conducted annually by the Japan Sports Agency (JSA) since 1964.
(Note, it was performed by the Ministry of Education, Culture, Sports, Science and
Technology (MEXT) until 2015). The test battery and the target sample have been
changed occasionally. Initially, the JP Fit Survey for All Ages targeted only individuals
aged 12–29 years, with the target age demographic expanding gradually over time (those
aged 10–11 years were included from 1965 and those aged 30–59 years were included
from 1967). Since 1983, those aged 6 years (first-year students at elementary school) or
older were included, with Japanese people aged 6–59 years measured up until when it was further revised in 1998. The PF test battery differed according to the age group. Table 1 shows the PF test items according to age group.

**Table 1 around here**

In 1998, the PF surveillance system was revised to include a new fitness battery and a wider age demographic (aged 6–79 years) (hereafter referred to as the “new physical fitness test”). There were changes in social needs regarding PF, such as temporal declines in PF among Japanese people (12), advances in sports and exercise science, and progression into a super-aging society (13). To better understand the age-related changes in PF, three PF tests (i.e., handgrip strength (muscular strength), sit-ups (muscular endurance), and sit and reach (flexibility)) were adopted as common PF tests across all age groups (aged 6–79 years). The consistency of PF tests over time was important to monitor trends in PF levels, with some PF tests retained in the new physical fitness test battery (i.e., handgrip strength, 50 m sprint, standing long jump, ball throw, endurance run, sidestep, and rapid walk). The new physical fitness test battery is presented in Table 2.
2.2 Sampling methodology for the current Japanese PF surveillance system

JP Fit Survey for All Ages uses a repeated cross-sectional random sampling strategy to survey approximately 75,000 Japanese people (aged 6–79 years) annually. The PF survey has been performed annually between May and October, with the test results statistically processed and reported descriptively (e.g., sample sizes, means, standard deviations) each year since 1964. The sampling method employed has differed according to age group (6–17 years, 18–19 years, and 20–79 years). For school-aged children (aged 6–17 years), 50–60 students from each age-gender group randomly sampled from each of Japan’s 47 prefectures. Local education boards in each prefecture have randomly selected participating schools, with the selected schools asked to provide the PF data on their students. For those aged 18–19 years, JSA has randomly selected participating institutions according to three categories (university, junior college, and technical college), with the selected schools asked to provide the PF data on their students with target sample sizes of 600 per age-gender group. For those aged 20–79 years, participants have been recruited from all prefectures, with local education boards trying to recruit representative samples by recruiting residents from geographically diverse areas (both urban and rural areas).
within each prefecture, with target sample sizes of 20 (65–79 years) and 40 (20–64 years) per age-gender-prefecture group.

2.3 New PF surveillance for children and adolescents

In 2008, MEXT launched a new PF surveillance test for children and adolescents (called “National Survey of Physical Fitness, Athletic Performance and Exercise Habits” [hereafter referred to as the “JP Fit Survey for Youth”]). While JP Fit Survey for Youth is limited to year 5 (aged 10–11 years) and year 8 students (aged 13–14 years), all students (approximately 2 million students every year) in these age groups have been asked to participate in PF testing. There are several reasons for the development of JP Fit Survey for Youth. As mentioned earlier, JP Fit Survey for All Ages includes children and adolescents aged 6–17 years, with approximately 2000 schoolchildren in each age group. JP Fit Survey for All Ages has a sufficient sample size to understand population-level PF levels among children and adolescents; however, this survey is insufficiently powered to confidently make PF comparisons at the school level. In contrast, because the JP Fit Survey for Youth recruits all students in years 5 and 8 students, this enables us to compare PF at the school levels. The JP Fit Survey for Youth test results are reported descriptively and publicly available, with prefecture level rankings reported by mass media outlets (e.g.,
TV, newspapers). Additionally, the JP Fit Survey for Youth includes a questionnaire survey for school administrators that evaluates their efforts to improve PF levels among their children (e.g., Did your school set any goal to improve children’s PF level this year?). It is suggested that this survey be used to increase social interest in PF among children and adolescents. The JP Fit Survey for Youth test battery is the same as that for the JP Fit Survey for All Ages, inclusive of the eight PF tests shown in Table 2.

3. Previous publications using the database from Japanese PF surveillance

Table 3 shows a list of publications that have used the Japanese PF surveillance dataset. To the best of our knowledge, only seven international publications have used such data. Among them, three reported on school-aged children aged 11–17 years, one reported on university students, and three reported on older adults aged 60–79 years. Nishijima et al. examined temporal trends in PF levels (assessed as a composite PF score across 14 PF tests) for Japanese youths aged 12–17 years between 1964 and 1997. The authors categorized the 34 years into three periods (1964–1974, 1975–1985 and 1986–1997) and found a significant increase in PF levels between 1964 and 1974, followed by a significant decline between 1986 and 1997. Using PF data across the period 1964 to 1997, Noi et al. examined the potential effect of changes in physical
education (PE) curriculum in Japanese schools on the PF levels of children aged 11, 14, and 17 years. The authors suggested that having PE curriculum that emphasizes “PF” might have resulted in higher PF levels among youth, while a shift to play and fun might have resulted in lower PF levels. Additionally, we examined temporal trends in handgrip strength and body mass index (BMI) of Japanese university students aged 18 years and compared the results with those of the general population using age- and sex- matched national PF between 1973 and 2016. We found that the sport university students had greater BMI and stronger grip strength at all times compared to the general population. For older adults aged 60–79 years, we recently published studies in three international peer-reviewed journals on trends since 1998 for handgrip strength, 6-minute walking distance, balance, and walking speed. Collectively, there were small to moderate improvements in mean handgrip strength (change: 1.4 kg or 5%), 6-minute walking distance (change: 45 m or 8%), balance (change: 21 seconds or 33%), and walking speed (change: 0.2 seconds or 11%) among older Japanese adults over the past 20 years. These results suggested an overall improvement in PF among older Japanese adults. In these studies, we calculated population-weighted mean changes by pooling the changes across all relevant gender-age groups using a post-stratification procedure, which corrected sampling bias and standardized the changes to underlying population
Additionally, we predicted trends in distributional variability (the coefficient of variation [CV]), which is unique to the literature. Examining trends in distributional variability can provide important insights, by indicating whether trends in PF were uniform or non-uniform across the population, and thus, potentially improve our understanding of how best to address negative trends should they exist.

4. Priority research agenda

In this section, we propose five priority research agendas regarding Japanese PF surveillance: 1) more international publications using the Japanese PF surveillance dataset; 2) the establishment of criterion-referenced, health-related cut-points for PF; 3) PF surveillance to evaluate physical activity (PA) interventions; 4) the standardization of the English name for PF surveillance; and 5) improve the awareness of the open PF surveillance dataset.

4.1 More international publications using Japanese PF surveillance data

As mentioned in Section 3, only seven international studies have used the national PF
surveillance dataset \(^{12,14-19}\). We believe that the main strength of Japan’s PF surveillance is the extensive study period, allowing temporal trends to be estimated using annual PF data collected over more than half a century (since 1964). Even with a shorter study period (between 1998 and 2018), our recent analysis of trends in PF for older Japanese adults were published in well-recognized peer-reviewed international journals \(^{17-19}\). Japan’s PF surveillance strategy provides a lesson learnt for other countries to follow in order to monitor trends in population health and the effectiveness of implemented public health policy. It is for these reasons why we believe international audiences will be interested in Japan’s long history of national PF surveillance. While we have published trends in PF for older adults, our analytical approach can be used to examine trends for Japanese children, adolescents, and adults. Importantly, no study has examined temporal trends in PF among Japanese youth since 1998, using the new physical fitness test battery. There is, therefore, an opportunity to examine recent trends in PF for youth.

4.2 Criterion-referenced cut-points for the PF tests

The current PF surveillance system uses normative-referenced cut-points. In other words, the PF levels of participants are assessed using a letter grade framework — comprising five grades from A (most fit) to E (least fit) — based on their composite PF score,
calculated by summing scores across multiple PF tests. The grading framework is based on the data distributions of PF scores in each age-sex group, allowing participants to use their grades to interpret whether their PF is low, moderate, or high relative to their age- and sex-matched peers. However, the degree to which such normative-referenced cut-points are related to health outcomes is unknown. To help resolve this, criterion-referenced, health-related cut-points for field-based PF tests have been proposed, although universal age- and sex-specific cut-points are yet to be established. We have published studies that examined the cross-sectional and longitudinal associations of field-based PF tests (from the new physical fitness test battery) with cardiovascular biomarkers in Japanese children and adolescents. Such studies are needed to establish criterion-referenced, health-related cut-points for the Japanese people as cut-points vary across countries, races, and ethnicities.

4.3 PF surveillance to evaluate PA interventions

In 2020, the World Health Organization (WHO) released new PA and sedentary behavior guidelines for children, adolescents, adults, and older adults with target amounts of PA (frequency, intensity, and duration) required to achieve minimum health benefits. In Japan, ActiveGuide (Japan’s official physical activity guideline for health promotion) was
released with PA targets for Japanese people that are higher than those recommended by the WHO. To evaluate the effectiveness of these guidelines, it is necessary to regularly monitor PA at the population level. There are several national surveys to evaluate exercise habits of the Japanese population which use self-report questionnaires, including the National Health and Nutrition Survey (performed by the Ministry of Health, Labour and Welfare), JP Fit Survey for All Ages, and JP Fit Survey for Youth. Although self-reported PA has several benefits related to feasibility, it may be susceptible to recall/response biases as well as low validity. On the other hand, objective PA measures, including pedometers and accelerometers, have recently become popular in PA research. However, objective PA measurement at the population level is not always possible because of feasibility issues (e.g., high cost, time-consuming). As an alternative, international experts have recommend using PF to evaluate PA interventions. This is because PF (in particular, cardiorespiratory fitness) is primarily determined by habitual PA, and can therefore be used as a proximal outcome of PA levels. Because Japan’s PF surveillance system includes field-based measures of cardiorespiratory fitness (e.g., the 20 m shuttle run or endurance run for children, adolescents, and adults, and the 6-minute walking distance for older adults), such PF tests could be used to complement the PA evaluation process.
4.4 Standardization of the English name for the PF surveillance

Although the official English name for JP Fit Survey for All Ages (i.e., Survey on Physical Fitness and Motor Abilities) and JP Fit Survey for Youth (i.e., National Survey of Physical Fitness, Athletic Performance and Exercise Habits) were decided by the government, there were significant variations in the used English name across studies. For example, as for JP Fit Survey for All Ages, Nishijima et al.¹⁴) used “National Statistical Survey on Physical Fitness and Motor Ability,” while Noi et al.¹⁵) used “Surveys of Physical Fitness and Athletic Ability.” The inconsistency clearly indicates a need for standardizing the English name for the Japanese PF surveillance. It is preferable to reach a consensus among academic experts regarding the official English name, which is essential to support international publications using the Japanese PF database.

4.5 Improve the awareness of the open PF surveillance dataset

It may be misunderstood that the availability of raw data for both surveillance datasets (JP Fit Survey for All Ages and JP Fit Survey for Youth) is restricted to specific research groups or institutions. However, the raw data for both surveillance datasets are available for anyone following the submission of a request for such data, which includes submitting
a research proposal to JSA and MEXT. We believe that resolving this misunderstanding regarding the data availability for surveillance is essential to promote more international publications by various research groups. Additionally, other suggestions include the improvement of the quality of data in the annual report book. In the current format, only descriptive data (e.g., sample sizes, mean, standard deviations) are available for each PF test. More detailed and simple statistics, such as percentile values, can improve clarity on the distributional variability and asymmetry of the data. For example, these statistics enable us to determine whether declines in mean PF have been uniform or non-uniform across the population distribution.

5. Conclusion

This short review summarizes the history and test battery of the annual national PF surveillance system for Japanese people. Japan has a strong history of PF surveillance, and more international publications using its unique dataset are needed to encourage other countries to develop similar cost-effective public health surveillance strategies.

Author contributions:

TK and KS drafted the manuscript. All authors have critically reviewed, revised and
approved the manuscript.

Conflicts of interest:

The authors have no conflict of interests to declare.

Reference


21. Fraser BJ, Rollo S, Sampson M, Magnussen CG, Lang JJ, Tremblay MS and


Table 1. Previous Japanese physical fitness surveillance test battery, implemented from 1964 until 1997.

<table>
<thead>
<tr>
<th>Age group</th>
<th>6–9 years</th>
<th>10–11 years</th>
<th>12–19 years</th>
<th>30–59 years</th>
</tr>
</thead>
</table>
| Test items        | 50 m sprint
Standing long jump
Softball throw
Jump and pass under a rope
Running with a ball | Sidestep
Vertical jump
Back strength
Handgrip strength
Bend over backwards
Standing flexion
Step test
50 m sprint
Running long jump
Softball throw
Pull-up
Zigzag dribble
Continuous pull over | Sidestep
Vertical jump
Back strength
Handgrip strength
Bend over backwards
Standing flexion
Step test
50 m sprint
Running long jump
Handball throw
Pull-up
Endurance run | Sidestep
Vertical jump
Handgrip strength
Zigzag dribble
Rapid walk |
Table 2. Current physical fitness surveillance test battery (“new physical fitness test”), implemented since 1998.

<table>
<thead>
<tr>
<th>Common PF tests</th>
<th>6–11 years</th>
<th>12–19 years</th>
<th>20–64 years</th>
<th>65–79 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Handgrip strength</td>
<td>Sit-ups</td>
<td>Sit-and-reach</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age-specific PF tests</td>
<td>Sidestep</td>
<td>Sidestep</td>
<td>Sidestep</td>
<td>Single-leg standing balance test</td>
</tr>
<tr>
<td>20 m shuttle run (or endurance run)</td>
<td>20 m shuttle run (or endurance run)</td>
<td>20 m shuttle run (or rapid walk)</td>
<td>10 m obstacle walk</td>
<td></td>
</tr>
<tr>
<td>50 m sprint</td>
<td>50 m sprint</td>
<td>Standing long jump</td>
<td>6-minute walking</td>
<td></td>
</tr>
<tr>
<td>Standing long jump</td>
<td>Standing long jump</td>
<td>Handball throw</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Softball throw</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Authors</td>
<td>Year</td>
<td>Publication (IF)</td>
<td>Participants</td>
<td>Study period</td>
</tr>
<tr>
<td>---------------</td>
<td>------</td>
<td>---------------------------------------</td>
<td>-----------------------------</td>
<td>--------------</td>
</tr>
<tr>
<td>Noi et al.</td>
<td>2002</td>
<td>Health Promotion International (IF = 2.5)</td>
<td>Youth aged 11, 14 and 17 years (n = 658,425)</td>
<td>1964–1997</td>
</tr>
<tr>
<td>Nishijima et al.</td>
<td>2003</td>
<td>International Journal of Sport and Health Science (IF = N/A)</td>
<td>Youth aged 12–17 years (n = 12,832)</td>
<td>1964–1997</td>
</tr>
<tr>
<td>Author(s)</td>
<td>Year</td>
<td>Journal</td>
<td>Group Description</td>
<td>Time Period</td>
</tr>
<tr>
<td>---------------------</td>
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</tr>
<tr>
<td>Nishijima et al.</td>
<td>2003</td>
<td>International Journal of Sport and Health Science</td>
<td>Youth aged 17 years (n = 1,136)</td>
<td>1980-1997</td>
</tr>
<tr>
<td>Kidokoro et al.</td>
<td>2020</td>
<td>Journal of Exercise Science &amp; Fitness</td>
<td>Sport university students aged 18 years (n = 6,308) and the Japanese general population aged 18 years (n = 64,315)</td>
<td>1973-2016</td>
</tr>
<tr>
<td>Tomkinson et al.</td>
<td>2020</td>
<td>Age and Ageing (IF = 10.7)</td>
<td>Older adults aged 60–79</td>
<td>1998–2017</td>
</tr>
</tbody>
</table>
Improvement progressively increased over time, with more recent values (post-2008) 1.5-fold larger than earlier values. Gender- and age-related temporal differences were negligible. Variability in HGS declined substantially over time, with declines 1.9-fold larger in women compared to men and 1.7-fold larger in 70- to 79-year-olds compared to 60- to 69-year-olds.

| Tomkinson et al. 18 | 2021 | Journal of Sport and Health Science (IF = 7.2) | Older adults aged 65–79 years (n = 103,505) | 1998–2017 6-minute walking distance (6MWD) | There was moderate improvement in mean 6MWD of 45 m and 8%. Gender- and age-related temporal differences in means were negligible. Variability in 6MWD declined substantially, with declines larger for women compared to men, and for 75- to 79-year-olds compared to 65- to 74-year-olds. Concurrently, there were moderate and negligible increases in mean height and mass, respectively, and negligible increases in the percentage who participated in exercise/sport at least 3 days per week and at least 30 min per session. |
Kidokoro et al. 19)  

<table>
<thead>
<tr>
<th>Year</th>
<th>Journal of Exercise Science &amp; Fitness (IF = 3.1)</th>
<th>Participants</th>
<th>Tests</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>2021</td>
<td>Older adults aged 65–79 years (n = 114,785 for balance; n = 112,289 for walking speed)</td>
<td>1998–2018</td>
<td>Single leg standing test for balance; 10 m obstacle walking test for walking speed</td>
<td>There was a moderate improvement in both mean balance and mean walking speed. Improvements were seen in all gender and age groups, with small gender-related and negligible age-related temporal differences. Variability declined substantially for both balance and walking speed.</td>
</tr>
</tbody>
</table>

PF: physical fitness; IF: impact factor. IFs were reported based on the 2020 data.