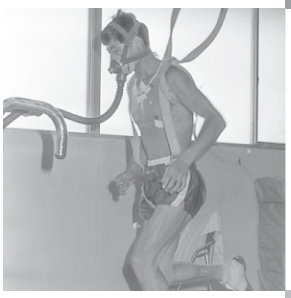
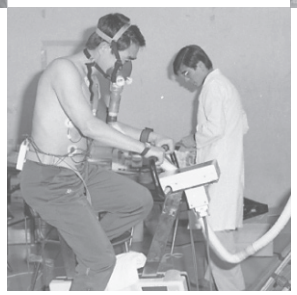
一流競技者の健康・体力追跡調査
—東京オリンピック記念体力測定—の総括

Follow up study on the TOKYO1964 Olympians

公益財団法人
日本スポーツ協会　Japan Sport Association (JSPO)








プロジェクト概要

公益財団法人日本スポーツ協会 スポーツ医・科学委員会 委員長
川原　貴

1．プロジェクトの背景

このプロジェクトはもともとOlympic Medical Archives（OMA）として開始されたものである。OMA は、1964年に東京で開催されたオリンピック競技大会（以下、「1964東京五輪」）を契機に国際スポーツ医学連盟（FIMS）が国際オリンピック委員会（IOC）、各国オリンピック委員会（NOC）、世界保健機構（WHO）の協力のもと、オリンピック大会参加選手の健康と体力を生涯にわたって調査し、その記録をスイス・ローザンヌのオリンピック博物館に保存するという事業であった。しかしながら、1972年には参加国が減少し、OMAは中止となった。日本体育協会（現日本スポーツ協会）のスポーツ科学委員会（現スポーツ医・科学委員会）はこの事業の意義と重要性に鑑み、「東京オリンピック記念体力測定」の名称で4年ごとに調査・測定することを1968年に決定し、現在に至るまで継続してきた。2005年の第10回以降は日本スポーツ協会（JSPO）と国立スポーツ科学センター（JISS）との共同研究として実施している。

2．調査対象者

1964東京五輪の選手（候補含む）（以下、「1964東京五輪選手」）380名（男314名、女66名）を対象にアンケート調査と体力測定、医学的検査・診察を行ってきた。図1はアンケート調査に参加した選手と体力測定、医学的検査・診察に参加した選手の推移を男女別に示している。直近の2016年第13回測定時点では物故者80名（男75名、女5名）、消息不明27名を除く、273名にアンケート調査を送付し、177名（男、132名、女45名）から回答をえた。回答者の年齢は75.4±3.6歳（男76.0±3.5歳、女73.5±3.3）であった。このうち体力測定、医学的検査・診察を受けたのは106名（男79名、女27名）であった。

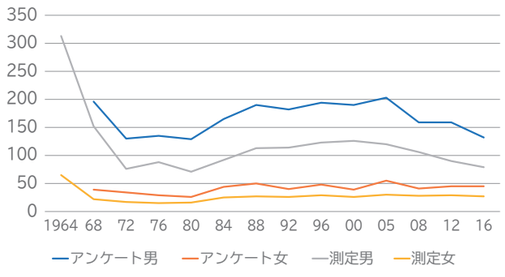


図1　アンケート、測定参加者の推移

3．調査項目

1968年第1回はアンケート調査と体力測定、一般臨床検査のみであったが、1976年第3回からは整形外科診察、1988年第6回からは内科診察、2008年第11回からは歯科の診察、検査が加わった。2016年第13回では、ロコモティブシンドローム、フレイル、サルコペニアの調査を行った。調査項目は以下のとおりである。

1）アンケート調査
- 職業、婚姻、子供の数、喫煙、飲酒、睡眠、食事、競技歴、運動習慣、健康状態、怪我、病気など

2）体力測定
- 形態：体重、身長、座高、胸囲、腹囲、皮下脂肪、四肢周径
- 機能：背筋力、握力、腕屈曲力、脚伸展力、垂直飛び、反復横跳び、全身反応時間、体前屈、上体そらし、全身持久力

＊被験者の年齢も考慮し、2005年第10回測定以降の体力測定は形態、握力、長座体前屈、閉眼片足立ち、開眼片足立ちのみとした。

3）一般臨床検査：血圧、心電図、胸部X線、血液検査、尿検査

4）整形外科診察
- 腰、膝、その他の痛みに関するアンケート
- 診察、膝・腰のX線検査、骨密度

5）内科診察

6）歯科診察

7）フレイル、サルコペニア、ロコモティブシンドローム

4．調査結果の概要

1964東京五輪選手は競技引退後も運動習慣のある人が多く、高齢になっても一般人より高い筋力を保っていた。高血圧、糖尿病、脂質異常症は一般人より少なく、死亡率も低かったが、高尿酸血症、痛風は多くみられた。また、高齢になっても骨密度が高く保たれていたが、体の痛みを訴える人が多く、バランス能力、歩行速度は一般高齢者より低い傾向がみられた。
青年期にスポーツに打ち込み、その後もスポーツ習慣を持つことは、健康にとって益することが多いが、高齢期に体の痛みを訴える選手が多く、青年期の競技における外傷、障害をなるべく予防し、体のケアを怠らないことが重要と考えられる。

謝辞：本調査は長年にわたって非常に多くの方々の協力で実施されてきたものであり、協力いただいた方々、測定を受けていただいたオリンピアンに感謝いたします。

Project Summary

Chair, Sport Medicine and Science Research Committee, Japan Sport Association
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1. Project background

This project was originally started as the Olympic Medical Archives (OMA). The OMA was an initiative by the International Federation of Sports Medicine (FIMS), in collaboration with the International Olympic Committee (IOC), the National Olympic Committee (NOC), and the World Health Organization (WHO) to use the Games of the Olympiad held in Tokyo in 1964(hereafter, “TOKYO1964”) as an opportunity to survey the health and physical fitness of athletes who took part in the Olympic Games over their entire lives and preserve a records of this survey in the Olympic Museum in Lausanne, Switzerland. However, the number of participating countries decreased in 1972, and the OMA was discontinued. Considering of the significance and importance of this initiative, the Sports Science Committee of the Japan Sport Association decided in 1968 to conduct surveys and measurements every four years under the name “Tokyo Olympic Commemoration Physical Fitness Study” and has continued to do so to the present. Since the 10th study in 2005, it has been conducted as joint research between the Japan Sport Association and the Japan Institute of Sports Sciences (JISS).

2. Survey subjects

Although 355 athletes (294 men and 61 women) competed in the TOKYO1964(hereafter, “TOKYO1964 Olympians”), the questionnaire surveys, physical fitness measurements, and medical examinations and consultations targeted 380 individuals (314 men and 66 women) that included candidate athletes. Figure 1 shows the changes in athletes who participated in the questionnaire surveys as well as those who participated in the physical fitness measurements and medical examinations and consultations for male and female separately. At the time of the most recent study (the 13th) in 2016, the questionnaire surveys were sent to 273 people, excluding 80 deceased individuals (75 men and 5 women) and 27 who could not be located. Of the 177 who responded, 132 were men and 45 women. The ages of the respondents were 75.4±3.6 (76.0±3.5 for the men and 73.5±3.3 for the women). Of these, 106 (79 men and 27 women) had undergone physical fitness measurements and medical examinations and consultations.

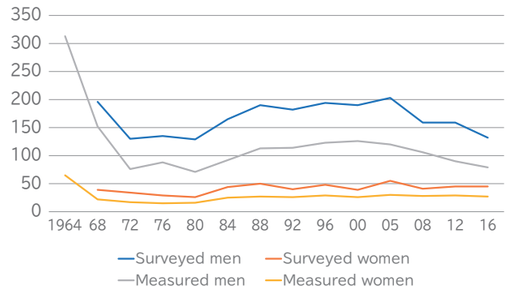

Figure 1: Changes in questionnaire survey and measurement participants

3. Survey items

The first time this study was done (1968), only the questionnaire surveys, physical fitness measurements, and general clinical examinations were conducted. Orthopedic examinations were added starting from the third in 1976, with internal medicine examinations added from the sixth in 1988 and dental examinations added from the 11th in 2008. Surveys of locomotive syndrome, frailty, and sarcopenia were conducted at the 13th in 2016. The survey items were as follows.

1) Questionnaire survey
- Occupation, marital status, number of children, smoking, drinking, sleep, diet, sporting history, exercise habits, health status, injuries, diseases, etc.

2) Physical fitness measurements
- Morphology: Body weight, body length, sitting height, chest circumference, abdominal circumference, subcutaneous fat, limb circumference
- Function: Back strength, grip strength, arm flexion strength, leg extension strength, vertical jump, repeated side steps, whole body reaction time, anteflexion, upper body deflection, whole body endurance

＊The ages of the subjects were also taken into consideration, and starting from the 10th measurements in 2005, only morphology, grip strength, long-seated anteflexion, one-leg standing with eyes closed, and one-leg standing with eyes open were investigated.

3) General clinical examinations: Blood pressure, electrocardiogram, chest x-ray, blood tests, urine tests

4) Orthopedic examinations
- Survey on hip, knee, and other pain
- Consultations, knee and hip x-ray examinations, bone density

5) Internal medicine consultations

6) Dental consultations

7) Frailty, sarcopenia, locomotive syndrome

4. Summary of survey results

Many of the TOKYO1964 Olympians continued exercise habits even after retiring from competition, and even in old age maintain higher muscle strength than in the general population. They had lower incidences of hypertension, diabetes, and dyslipidemia than the general population, and their mortality rates were low, however many cases of hyperuricemia and gout were observed. Also, although bone density had been maintained at a high level even after reaching old age, many complained of body pain, and a tendency to have lessened balance ability and walking speed than the elderly in general was observed.

It is often beneficial to one’s health to devote oneself to sports in adolescence and stay in the habit of participating in sports afterwards, but as many athletes complain of body pain in old age, it seems important to prevent injury and disability when competing during adolescence to the greatest extent possible and avoid neglecting taking care of one’s body.

Acknowledgments: This survey was conducted over a long period of time with the cooperation of a great many people, and we would like to thank all those who cooperated as well as the TOKYO1964 Olympians who agreed to undergo the measurements.

1964東京五輪選手の体力および運動・スポーツ実施状況の推移

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●研究結果の概要

- 筋力、瞬発力および敏捷性は、青年期における1964東京五輪選手と一般人との差が、高齢期に至るまでほぼ変わらない傾向にあり、両者の加齢に伴う低下傾向に明確な差は認められなかった。
- 柔軟性と平衡性は、個人差(偏り)が大きく、1964東京五輪選手が一般人を下回る傾向も認められた。
- 運動・スポーツを週１回以上実施している割合については、青年期から中年期にかけて男女ともに1964東京五輪選手が一般人に比べて高い値を推移していたが、高齢期に至るにつれて一般人との差が徐々に縮まる傾向にあった。

●体力について

筋力(握力：第１～13回まで測定実施)は、1964東京五輪選手の男性において全サンプル数の約20%程度が一般人(首都大学東京体力標準値研究会、2007)を下回っているものの、女性のほとんどが一般人を大きく超えており、平均的にみると男女ともに一般人よりも高い傾向にあった。また、1964東京五輪選手の男女ともに30歳前後から徐々に低下するなど、加齢に伴う低下傾向が一般人と類似していた(図１)。この傾向は、第１～９回まで測定を実施していた背筋力についても同様であった。

また、瞬発力(垂直跳)は、1964東京五輪選手および一般人ともに加齢にともない直線的に低下していたが、両者の差は高齢期に至るまで維持される傾向にあった(図２)。同様の傾向は、敏捷性(反復横跳)にも認められたことから、瞬発力や敏捷性も、筋力と同様に青年期に高めた体力要素の「持ち越し効果(図３)」が期待できることを示唆しているといえる。

なお、柔軟性(立位体前屈、長座体前屈)と平衡性(閉眼片足立ち、開眼片足立ち)は、男女ともに偏りが大きく、1964東京五輪選手の多くが一般人よりも低い値を示すなど、加齢に伴う変化を含めて一定の傾向を捉えることはできなかった。平衡性は、機能項目のなかでも加齢変化が顕著であるといわれているが、この点については、平衡機能の老化メカニズムや下肢のアライメントの影響なども含めて検討する必要があると考えられる。

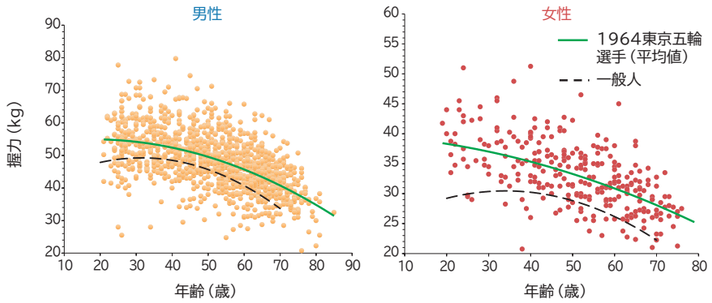

図１　筋力(握力)

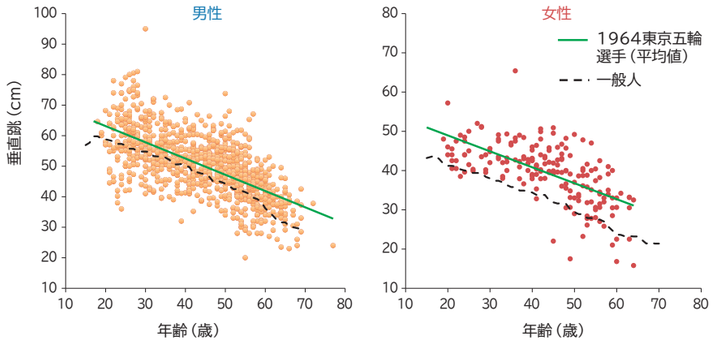

図２　瞬発力(垂直跳)

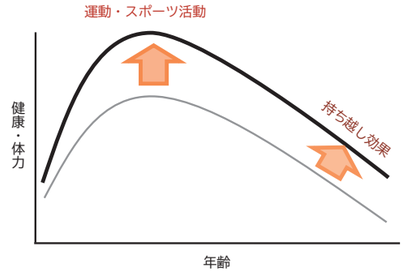

図３　健康･体力の持ち越し効果(概念図)

●運動・スポーツ実施状況について

1964年東京大会終了後、ほとんどの1964東京五輪選手が競技的活動を停止したと考えられる第４回測定時(男性40.3歳、女性38.4歳)において、週１回以上の運動･スポーツ実施者(以下、実施者)の割合は、1964東京五輪選手の男性が56.1%、女性が72.7%であり、40歳代の一般人男性の34.3%、30歳代の一般人女性の30.2%を大きく上回っていた(図４：比較対象となる一般人のデータについては、総理府･内閣府および文部科学省の「体力･スポーツに関する世論調査」とスポーツ庁の「スポーツの実施状況等に関する世論調査」の同時期・同世代のデータを参照した)。

40歳代から50歳代半ば(第８回測定時：男性56.4歳、女性54.5歳)にかけては、1964東京五輪選手の男性が56.1%から45.6%、女性が72.7%から56.0%といずれも低下傾向にあったが、依然として一般人(50歳代の一般人男性の32.3%、女性の41.7%)を上回っていた。その後は、第13回測定時(男性76.0歳、女性73.5歳)に至るまで、1964東京五輪選手の男女ともに60%前後での増減(高止まり)を示しており、70歳を超えたあたりから一般人の割合が若干上回っていた。

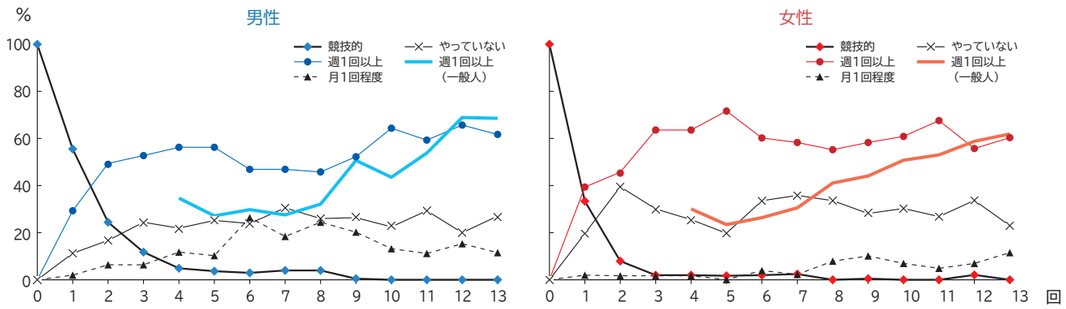

図４　運動・スポーツ実施状況の推移

●おわりに

過去の運動習慣と現在の健康や体力との関連の有無については様々な見解があるが、過去の運動経験と現在の運動習慣との間には中程度の関連があることも指摘されている(Suzuki and Nishijima, 2005)。1964東京五輪選手において、握力をはじめとする体力要素にみられた「持ち越し効果」は、現役引退後から働き盛りの中年期を経て高齢期に至るまでの、一般人に比して高い運動・スポーツ実施率がもたらしたものであると推察される。握力は、全身の多くの部位の筋力との相関関係が高く、総・原因別死亡および疾病リスクとも関連していることが、国内外の多くの研究によって指摘されている。これらのことは、青年期以降の運動・スポーツ習慣と体力要素が相乗的・循環的な効果を生みながら中高年期まで持ち越されてきたことが、1964東京五輪選手が一般人に比べて、自身の健康や体力に自信があることや、介護認定率も低い傾向にあること(日本体育協会、2016)などにもつながっている可能性を示唆するものである。

したがって、青少年期における運動・スポーツ実践を定着させ、それを生涯にわたって習慣化することは、中高年期以降も健康で豊かな生活を送るために必要な要素の一つであるといえるだろう。

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運動器の整形外科的評価
（骨密度および腰椎・膝関節の疼痛と単純X線所見）

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●研究結果の概要

- 若年期に高度の運動負荷環境に曝されていたと考えられる1964東京五輪選手の運動器の症状と変化及び骨密度について調査を行った。
- 代表的な運動器である腰椎および膝関節の「疼痛の自覚」は経年的に増加し、2016年（第13回）の調査時、平均年齢＝75.5歳（男性73.9歳、女性76.1歳）では、腰椎で48.5％（男性48.1％、女性50.0％）、膝関節で40.6％（男性35.4％、女性51.9％）の方が疼痛を自覚していた（図１、２）。
- 単純X線による評価でも、腰椎および膝関節の「変形性関節症性変化」（Kellgren-Lawrence分類Ⅱ度以上）は経年的に進行し、腰椎で90.6％（男性91.4％、女性88.9％）、膝関節では50.9％（男性44.3％、女性70.3％）が変形性関節症を呈していた。その一方で、疼痛や不具合を感じながらも運動器の機能は高いレベルを維持できているようであった（図３、４）。
- 「骨密度」については健常若年成人の平均値と比較しても極めて高い値を維持し、これは筋力や筋重量と相関があることが分かった。
- 以上より、若年期における十分量の運動負荷環境は、年齢相応の運動器の変化と症状を来すが、おもに若年期に蓄積された筋量や筋力によって、運動器の機能と骨密度は高いレベルを維持出来ていると考えられる。

●高齢者の運動器の特徴

運動器は人が身体を動かすために自分の意志で活用できる唯一の身体器官である。しかしながら、高齢になると、運動器の構造や機能に様々な変化や障害が出てくることが知られている。このため高齢者の運動器疾患へのアプローチとして、脆弱性骨折の原因となる骨粗鬆症の治療や、運動機能維持のための運動療法が推奨されている。

また、高齢者の運動器は、個人のそれまでの生活様式や習慣の影響を受けると言われており、若年期に十分な量の運動負荷と運動習慣を有していたと考えられる1964東京五輪選手について、東京五輪開催年から2016年までの52年間にわたり、オリンピック開催年ごとに体力測定とメディカルチェックを実施してきた。本調査は現在では高齢者の運動器に関する貴重なデータとも言え、ここでは2016年（第13回）に行われた体力測定とメディカルチェックの結果を中心に、代表的な運動器である膝関節と腰椎の機能と関節の評価、および全身の骨密度について解説する。因みに2016年調査時の代表選手の平均年齢は75.5（男性＝76.1、女性＝73.9）歳である。

●関節の痛み

各回調査時における腰および膝関節の持続する痛みの有無について調査した。

①腰の痛み（図１）：「現在、持続する腰痛がある」と回答した人の比率は、2005年の第10回（平均年齢64.9歳）では28.0％（男性28.1％、女性29.1％）あったが、その後徐々に増加し、2016年（第13回）では48.5％（男性48.1％、女性50.0％）の方が腰痛を自覚していた。一方、一般人を対象とした調査では、50歳以降は年齢による変化は少なく、腰痛を自覚している人の割合は約30％程度（男性28.3％、女性31.2％）と言われている[2)]。

②膝関節の痛み（図２）：腰痛と同様、「現在、持続する膝痛がある」と回答した人の比率は、2005年（第10回）では17.3％（男性17.2％、女性34.5％）であったが、2016年（第13回）には40.6％（男性35.4％、女性51.9％）まで増加していた。こちらも一般の人々を対象とした調査と比較すると、60歳以上で32.8％（男性24.1％、女性37.6％）とされており[3)]、年齢による増加を考慮すれば大きな違いはないようである。

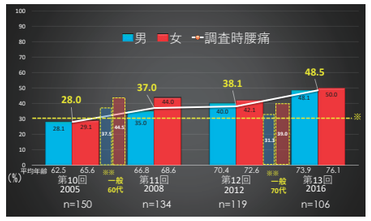

図１　調査時腰痛の有無（男女別と平均）
※一般（50歳以上）における腰痛自覚者の比率30％（男性28.3％、女性31.2％）[2)]（村木ら、2012）
※※一般（60歳代、70歳代）における腰痛自覚者の比率[5)]（吉村ら、2014）

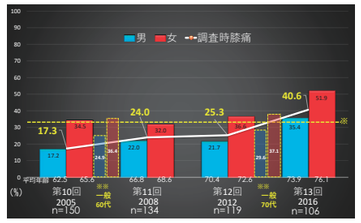

図２　調査時膝痛の有無（男女別と平均）
※一般（60歳以上）における腰痛自覚者の比率32.8％（男性24.1％、女性37.6％）[3)]（村木ら、2009）
※※一般（60歳代、70歳代）における腰痛自覚者の比率[5)]（吉村ら、2014）

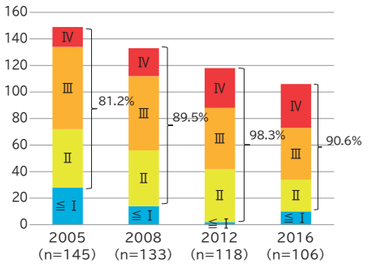

図３　各評価時における変形性腰椎症の重症度（K-L分類≧Ⅱ）の比率

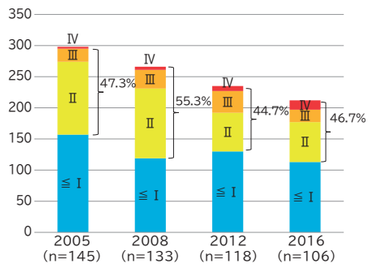

図４　各評価時における変形性膝関節症の重症度（K-L分類≧Ⅱ）の比率

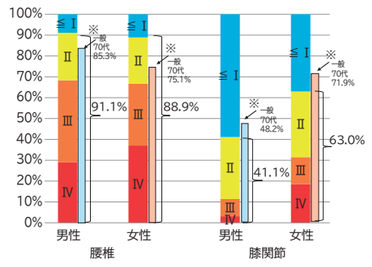

図５　2016年の評価時における変形性関節症（腰椎・膝関節）の重症度の比率
※一般（60歳代、70歳代）における腰痛自覚者の比率[5)]（吉村ら、2014）

●関節の変化

関節の評価は第４回（1980年）以降、腰椎（正面・側面）および膝関節（正面・側面）の単純X線撮影が実施され、第10回（2005年）以降は変形性関節症の重症度の評価として広く普及しているKellgren-Lawrence（K-L）分類[4)]による５段階評価（０～Ⅳ）を用いて判定した。

①腰椎の関節症性変化（図３）：K-L分類においてⅡ度（軽症）以上の変形性関節症性変化を呈した人の割合は2005年81.2％であったが2016年の評価時には90.6％（男性91.1％、女性88.9％）（図５）に増加していた。

②膝関節の関節症性変化（図４）：腰椎と同様に軽症以上（K-L＞Ⅱ）の変形性関節症の所見を呈した人の比率は2005年47.3％であったが、2016年では46.7％（男性41.1％、女性は63.0％）と大きな変化はなかった。ただし、重症者の比率は増加しているようで、人工関節などの手術を受けた方が６名（全例女性）いた。膝関節では男女差があり、女性の方が関節の変化が著しいと言える（図５）。同年代の一般の方を対象とした調査報告[5、6)]と比較すると、腰椎の変形性関節症変化は若干強く、膝関節は若干低い値となっていたが、大きな差は無いようである。

●運動器の機能

日本整形外科学会では、高齢者の運動機能の総合的な低下をロコモティブシンドロームとして提唱しており、その評価指標として、運動機能（立ち上がりテスト・２ステップテスト）と自覚症状（ロコモ25）を用いたロコモ度テストを展開している。このテストは重症度を２段階に分けているが、1964東京五輪選手に実施したところ、各テストでロコモ度１にも２にも該当しない方（ロコモ度０）の割合は、自覚症状（ロコモ25）では46.1％であったのに対し、運動機能評価と言える、立ち上がりテスト（66.0％）、２ステップテスト（78.4％）では非常に高い割合を示し、自覚症状に比して高い運動機能が維持されているようである（図６）。

●骨密度

骨密度（全身）の評価は第８回（1997年）から実施しているが、時期によって計測機器が異なるため、単純に経時的変化を比較することは困難であるが、各実施回を通じ、若年成人（20～44歳）の骨量の平均値（Yang adult mean: YAM）との比較で男女ともに70％未満の方はおらず、臨床的に骨粗鬆症に該当する人はいなかった（表１）。

骨密度が高いレベルで維持されている理由の検討として、代表選手の身体計測値（身長・体重・BMI・握力）を同年代の一般人の値[7)]と比較したところ、BMIは標準値を維持しながらも、身長、体重は一部の年代を除き、一般人より高値を示し、特に握力はすべての年代で上回っており、1964東京五輪選手は体格に恵まれ、筋量も多いようである（表２）。更に、骨密度と筋肉量、および握力では正の相関関係が認められ、筋量もしくは握力が高値なほど骨密度も高い値を示していた（図７）。

一方、現在の運動習慣と筋肉量、握力、骨密度の関係では有意な関連は見いだせず、少なくとも現在の運動習慣というよりは、若年期の運動負荷と習慣が筋肉量や握力、骨密度に影響を及ぼした可能性が高いと思われる（図８）。

性	年齢	n	身長 (cm) 東京五輪	身長 (cm) 対照*	体重 (kg) 東京五輪	体重 (kg) 対照*	BMI 東京五輪	握力 (kg) 東京五輪	握力 (kg) 対照*
男性	65-69	19	170.3	*166.7*	69.7	*64.4*	23.9	40.9	*40.2*
	70-74	45	169.6	*164.8*	70.4	*62.4*	24.5	39.9	*38.1*
	75-79	18	169.3	*163.2*	67.8	*61.4*	23.6	37.9	*35.7*
	80＝	6	162.4		57		21.6	31.4	
	（平均）		169.2		68.8		24.0	39.1	
女性	60-64	1	149.7	*155.5*	48.4	*53*	21.6	31.8	*26.6*
	65-69	11	163.3	*153.7*	58.9	*52.3*	22	29.9	*25.3*
	70-74	10	157.4	*152*	57.6	*51.1*	23.1	28.4	*23.9*
	75-79	6	160	*150.6*	56.1	*50.2*	21.9	25.1	*22.8*
	（平均）		160.0		57.5		22.4	28.6	

表２　1964東京五輪選手と一般人の体格（身長、体重、BMI）、握力の比較
＊：平成29年度体力・運動能力調査報告書（スポーツ庁）

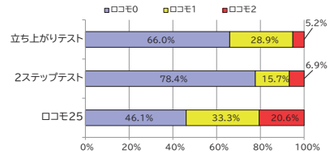

図６　各ロコモ度テストにおける対象者のロコモ度分布

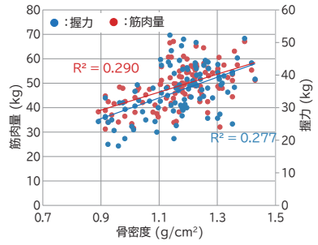

図７　骨密度と筋肉量および握力との相関（2016年）

実施回（年）	計測方法	男性 平均（最小値-最大値）	男性 YAM≦ 80	女性 平均（最小値-最大値）	女性 YAM≦ 80
第8回（1997）	定量的超音波法（QUS）	90.30%（71.0-113.0）	13人（12.1%）	92.60%（77.0-135.0）	2人（7.4%）
第9回（2001）	定量的超音波法（QUS）	93.80%（74.0-118.0）	9人（8.0%）	96.20%（78.0 -147.0）	2人（8.0%）
第10回（2005）	DEXA法（※）	97.00%（78-118.7）	3人（2.5%）	88.80%（75.6 -107.5）	4人（13.8%）
第11回（2008）	DEXA法（※）	96.40%（75.0-117.3）	2人（2.0%）	86.50%（75.5 -101.7）	4人（14.3%）
第12回（2012）	DEXA法（※※）	106.60%（81.0-127.0）	0人（0.0%）	94.40%（82.0 -118.0）	0人（0.0%）
第13回（2016）	DEXA法（※※）	104.80%（80.0-125.0）	0人（0.0%）	96.50%（81.0 -123.0）	0人（0.0%）

表１　骨密度（全身）の若年成人平均（YAM）値との比較
※、※※：それぞれ同一機種での計測による

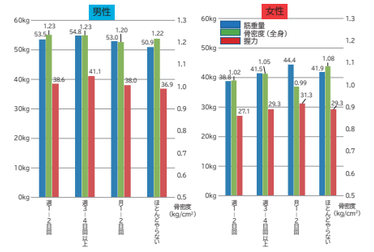

図８　運動習慣（頻度）と筋重量・骨密度（全身）・握力の関係（2012年）

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2）Muraki S, Akune T, Oka H, et al. Incidence and risk factors for radiographic lumbar spondylosis and lower back pain in Japanese men and women: the ROAD study. Osteoarthritis Cartilage 20（7）:712-8. 2012.

3）Muraki S, Oka H, Akune T, et al. Prevalence of radiographic knee osteoarthritis and its association with knee pain in the elderly of Japanese population-based cohorts: the ROAD study. Osteoarthritis Cartilage. 17(9):1137-43. 2009.

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6）Yoshimura N, et.al. Prevalence of knee osteoarthritis, lumbar spondylosis, and osteoporosis in Japanese men and women: the research on osteoarthritis/osteoporosis against disability study. J Bone Miner Metab. 27(5):620-8. 2009.

7）平成29年度体力・運動能力調査報告書（スポーツ庁）

生活習慣病の有病率

蒲原　一之[1)]　土肥　美智子[1)]

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●研究結果の概要

東京オリンピック記念体力測定追跡調査の対象は、1964東京五輪選手として参加した380名(男性314名、女性66名)である。調査は1968年に第１回目が行われ、以後４年ごとに行われており、直近では2016年に第13回目の調査が行われた。第13回調査においてメディカルチェックを受診したものは106名(平均年齢75.5±3.6歳)であり、その内訳は男性79名(平均年齢76.1±3.4歳)、女性27名(平均年齢74.0±3.5歳)であった。

若い時にスポーツ、それもかなり激しい運動を日常的に実施した影響が、年齢を重ねるにつれてどのようになるのかについて、これまでの調査で得られたデータからふり返った。内科的な調査項目に関しては、具体的な血液検査項目などは、時代に伴う疾患概念の変化によって、各回で異なる項目が検査されているものもあるが、主な項目としては家族歴、既往歴(手術歴含む)、現病歴(治療中の疾患、内服薬、自覚症状の有無)、血圧、脈拍、身体所見、血液検査、尿検査、胸部X線撮影、安静時心電図検査が調査されている。高血圧、脂質異常症、糖尿病などのいわゆる生活習慣病は、一般的に年齢を重ねるほど有病率が高まるが、1964東京五輪選手でも、回を重ねるごとに概ね増加していた。そこで生活習慣病について、直近の第13回目の調査での有病率を、第13回調査に参加した人と、同年代の一般高齢者と比較したので以下に示す。

●高血圧

第13回調査時に実施した血圧測定において、収縮時血圧が140mmHg、拡張期血圧が90mmHg以上であった人、もしくは第13回調査時点までに高血圧と診断されて薬を服用した経験のある人を高血圧と定義した。第13回調査において、高血圧のものは男性41名(51.9%)、女性11名(40.7%)であった。一般人を対象とした厚生労働省の「平成26年国民健康・栄養調査」[1)]の結果では、70歳以上の男性で高血圧症有病者の割合は72.1％であり、女性では70.9%であり、男女ともに1964東京五輪選手で低い結果となった(図１)。第13回の調査において、高血圧と糖尿病を合併していたものは男性３名、女性２名であり、高血圧と脂質異常症を合併していたものは男性６名、女性１名であった。このうち、男性の２名は高血圧、糖尿病、脂質異常症の三者を合併していた。

●肥満

第13回調査時に測定した身長と体重からBody Mass Index(BMI)を算出し、BMI25以上を肥満と定義した。1964東京五輪選手のうち、BMI25以上の割合は、第13回調査においては、男性26名(32.9%)、女性５名(18.5%)であった。一方、同年代である70歳以上の一般男性では24.7%、一般女性24.7%（厚生労働省「平成26年国民健康・栄養調査」[1)])と1964東京五輪選手の女性で肥満の割合が低かった(図２)。

●脂質異常症

現在の脂質異常症の診断基準は、LDL-C≧140mg/dl、HDL-C＜40mg/dl、TG≧150mg/dlのいずれか又は複数を満たすものとなっているが、第13回調査時に実施した血液検査ではHDL-CとTGのみの測定であった。厚生労働省による「平成26年国民健康・栄養調査」[1)]の結果で、HDL-C＜40mg/dlまたは治療中のものを、脂質異常症が疑われるものとし統計をとったところ、70歳以上の一般男性では33.7%、女性36.2%であった。同様の基準で1964東京五輪選手に対し調査を行った結果、第13回調査での脂質異常症が疑われるものは男性14名(17.7%)、女性６名(22.2%)という結果となり、男女ともに1964東京五輪選手で脂質異常症が疑われるものの割合は低かった(図３)。

●糖尿病

第13回調査時に実施した血液検査において、HbA1cが6.5%以上であった人、もしくは第13回調査時点までに糖尿病と診断されて薬を服用した経験のある人を糖尿病と定義した。その結果、1964東京五輪選手の第13回調査における糖尿病有病者の割合は、男性10名(12.7%)、女性５名(18.5%)であった。一般人を対象とした厚生労働省の「平成26年国民健康・栄養調査」[1)]の結果では、70歳以上で「糖尿病が強く疑われるもの」の割合は男性で22.3%、女性で17.0%であり、男性では1964東京五輪選手のほうが低い結果となった(図４)。

●高尿酸血症

第13回調査時に実施した血液検査において、血中尿酸値が7.0mg/dl以上であった人、もしくは第13回調査時点までに高尿酸血症あるいは痛風と診断されて薬を服用した経験のある人を、高尿酸血症と定義した。第13回調査において高尿酸血症(尿酸7.0mg/dl以上)のものは男性18名(22.8%)、女性１名(3.7%)であった。厚生労働省の「平成26年国民健康・栄養調査」[1)]によると、70歳以上の高尿酸血症の割合は男性では13.6%、女性では4.6%であり、1964東京五輪選手の男性で高尿酸血症の割合が高かった(図５)。

●まとめ

70歳以上の一般高齢者と比較した場合、高血圧、脂質異常症、糖尿病などのいわゆる生活習慣病の発症率は1964東京五輪選手で男女ともに低く、肥満(BMI25以上)については東京オリンピックに出場した女性で低かった。また、高尿酸血症の割合については、一般人と比較して1964東京五輪選手の男性で高かった。これらの疾患の発症率と現在の運動習慣との間に関連はみられず、また、これらの発症率と実施していた競技種目との間にも関連はみられなかった。疾患の発症率と実施していた競技種目や現在の運動習慣との間の関連性については、この研究では競技種目別の母数が少なすぎるため、明らかにはできなかった。

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1）厚生労働省：平成26年国民健康・栄養調査報告. https://www.mhlw.go.jp/bunya/kenkou/eiyou/h26-houkoku.html

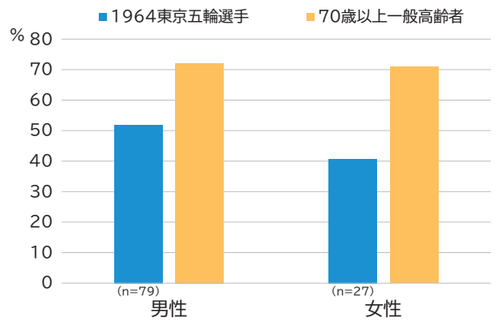

図１　高血圧有病率の比較(第13回調査時)

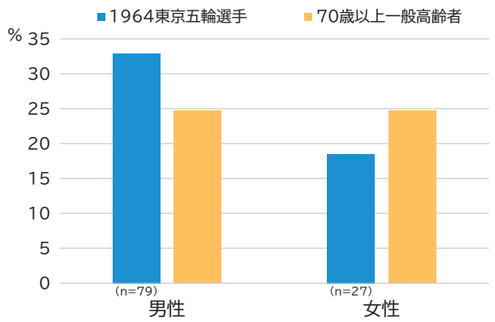

図２　BMIの比較(第13回調査時)

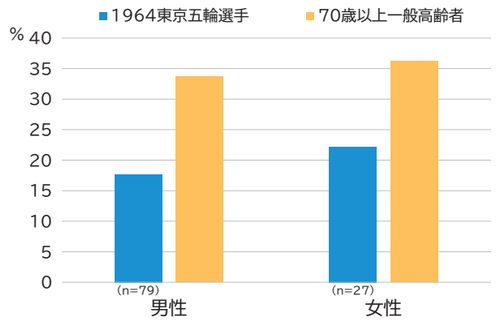

図３　脂質異常症有病率の比較(第13回調査時)

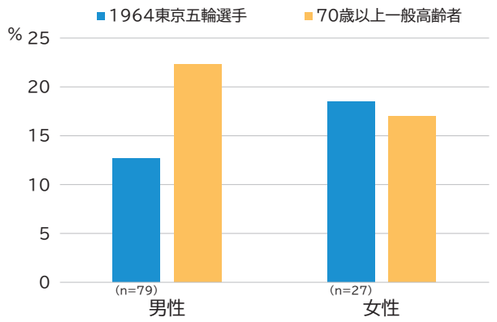

図４　糖尿病有率の比較(第13回調査時)

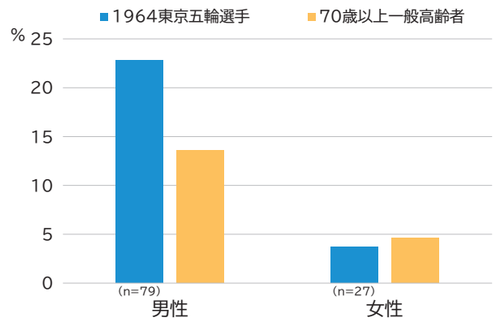

図５　高尿酸血症有病率の比較(第13回調査時)

運動・スポーツ実施状況と医学的評価の関係
―歯科的評価―

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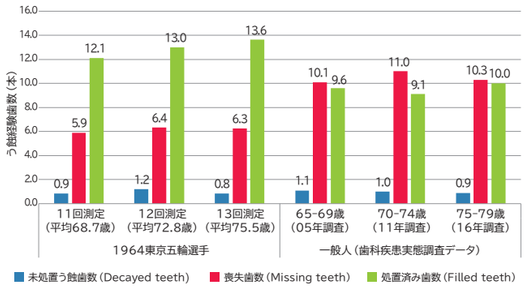
●研究結果の概要

東京オリンピック記念体力測定は1964年に東京オリンピックが開催されたことを契機として、1968年から４年ごとに50年以上にわたって継続実施されている一大研究プロジェクトである。歯科検診は2008年第11回測定から実施されるようになり、第12回および第13回測定を合わせて、計３回分の検診データが蓄積されている。今回改めてデータを分析評価した結果、以下の知見を得た。

- う蝕(むし歯)リスクが高く、処置を受けた歯は多い。
- 歯周病所見を認めない者が多いものの、実際には２極化傾向である。
- 喪失歯は少なく、一般高齢者より４－５本多く歯が残っている。
- 70代になっても、高いレベルの咀嚼機能を維持している。

以上より、かつての一流競技者の歯・口腔の健康状態は一般高齢者に比べて良好に維持されていると評価された。彼らが現役時代はもちろん、引退後も良好な運動習慣を維持してきた事実を考え合わせると、運動の持ち越し効果は歯・口腔の健康面にも表れると考えてよいのではないだろうか。

●う蝕リスクが高く、処置を受けた歯は多い



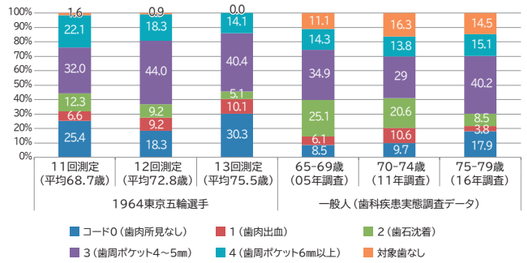
1964東京五輪選手と我が国の一般高齢者の平均う蝕経験歯数を比較したグラフである。う蝕経験歯数(Decayed, Missing, and Filled Teeth index：DMF or DMFT)とは自然治癒が期待できないう蝕の罹患状況やそれまでの経験を表す疫学指標の一つであり、未処置のう蝕歯(D)と喪失歯(M)、処置歯(F)を合計した歯数で表す。

図の左半分には2008年第11回測定、12年第12回測定および16年第13回測定にて歯科検診を受けた1964東京五輪選手の未処置歯数、喪失歯数および処置歯数の平均値が、右半分には05年、11年および16年実施の歯科疾患実態調査から得た一般高齢者のデータがそれぞれプロットされている。なお11回、12回および13回測定者数はそれぞれ123名(男性99名／女性24名、平均68.7歳)、109名(男84 ／女25、平均72.8歳)および99名(男75 ／女24、平均75.5歳)であった。

かつての一流競技者の特徴的所見として、う蝕処置歯数が多いことが挙げられる。11回測定と05年歯科疾患実態調査の差は2.5本、12回測定と11年調査の差は3.9本、13回測定と16年調査の差は3.6本多かった。スポーツ競技者のう蝕リスクは一般人に比べて高く、う蝕罹患率も高いことが国内外から報告されている。おそらくかつての一流競技者も現役時代多くの歯がう蝕になり、処置や治療を受けたと推察される。その結果として、処置歯数が多くなったと考えるのが合理的であろう。

もう一つ、喪失歯数が少ないことにも注目である。11回測定から12回、13回と同世代の一般高齢者より４本以上少ない傾向がずっと続いている。16年歯科疾患実態調査によれば、60代前半で平均4.6本、60代後半で6.7本、70代前半で8.6本、70代後半で10.3本の歯を失う。これが我が国の一般高齢者像である。ところが平均75.5歳の後期高齢者になった1964東京五輪選手の喪失歯数は6.3本に止まっている。ということは、彼らの口腔年齢は60代後半相当、実年齢より10歳以上若いと考えられる。

●歯周病の所見を認めないオリンピアンは多いものの、実際には２極化傾向



1964東京五輪選手と我が国の一般高齢者の地域歯周疾患指数の割合を比較したグラフである。地域歯周疾患指数(Community Periodontal Index of Treatment Needs: CPI or CPITN)とは1982年WHOが提唱した歯周診査法で、集団地域における歯周病の状態や治療の必要度を知るための指標である。

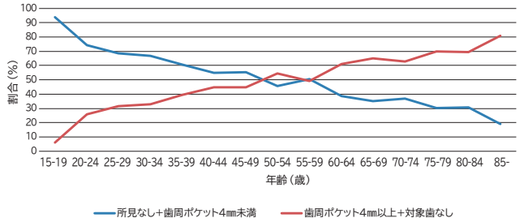
13回測定時のコード０(歯周病所見なし)者の割合は30.3%であった。16年歯科疾患実態調査のコード０者の割合は17.9%となっていることから、1964東京五輪選手は歯周病有病者が少ない集団と考えられる。ただしコード３(浅い歯周ポケット)者とコード４(深い歯周ポケット)者の割合を足すと54.1%～62.3%となり過半数を占めることから、実際には２極化傾向にあると思われる。それでも11回測定時からの変化を追うと、コード４者は22.1%，18.3%，14.1%と徐々に減少し、コード２(歯石沈着)者も７ポイント減少しているので、改善傾向にある。

●歯周病予防の３つの鍵は「正常体重の維持」「良質な食事」「活発な運動習慣」

高血圧症や糖尿病などと同様、歯周病も生活習慣病の一つである。そうした考え方に基づき、歯周病予防に繋がる３keys（３つの鍵)として、①正常体重の維持(BMI：18.5 ～ 24.9 m/kg^2)、②良質な食事(Healthy Eating Index：80以上)、③活発な運動習慣(週５回以上の中強度運動あるいは週３回以上の高強度運動)が提唱されている。とりわけ運動の効用については、海外の疫学調査研究から活発な運動習慣を有する集団の歯周病有病者率は有意に低いことが報告されているので、強調されるべきであろう。

1964東京五輪選手の運動実施状況であるが、13回測定時のアンケート調査に協力した273名中50名(18.3%)が週１～２日、56名(20.5%)が３～４日欠かさず運動している。現役時代の若い頃は言うまでもなく、引退後も良好な運動習慣を維持してきた集団と考えれば、運動習慣の維持が歯周病予防にも効くことを裏付けるデータの一つと見てよいだろう。したがって、かつての一流競技者は健康な歯周組織を持っている者が多く、歯周病になりにくい可能性が示唆される。

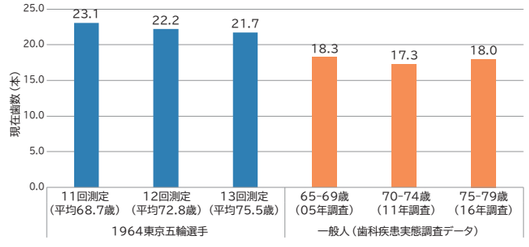
●一般に歯周病が本格化してくるのは50代から、定期検診と予防を



一般に歯周病が本格化してくるのは何歳からだろうか？ この点を明らかにするため、16年歯科疾患実態調査データを基に割り出した結果のグラフを示す。通常、歯周ポケット４㎜以上になると、セルフケアだけではプラークコントロールが難しくなるため治療が必要になってくる。そこでコード０、１および２の者(所見なし＋歯周ポケット４mm未満)と、コード３、４および対象歯なしの者(歯周ポケット４mm以上＋対象歯なし)の２群に分けてプロットしてみたところ、50代に２つの交点が確認された。よって、歯周病が本格化するのは50代からと言える。

歯周病は口の中のサイレント・ディジーズ(静かな病気)とも呼ばれ、自覚症状が出にくく、知らない間に進行している場合も多いので、３つの鍵を守りつつ、定期検診を受けて予防に努めることが大切である。

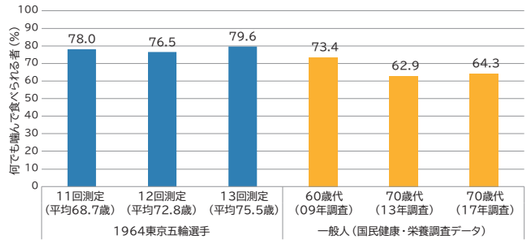
●一般の高齢者より、オリンピアンは４～５本多く歯が残っている



1964東京五輪選手と我が国の一般高齢者の歯数を比較したグラフである。左半分の東京オリンピアンの11回測定から13回測定データを平均すると22.3本である。一方、右半分の一般高齢者は平均17.9本で、その差4.4本である。

前述のように、1964東京五輪選手はう蝕による喪失歯数も少なく、健康な歯周組織を有する者が多いことから、同世代の一般高齢者より４～５本多く歯が残っている結果に繋がっていると思われる。参考までに、人の歯数は第３大臼歯(智歯、親知らず)を除けば、上下顎それぞれ14本ずつ計28本である。

●70歳代になっても、高いレベルの咀嚼力を維持している



1964東京五輪選手と我が国の一般高齢者の咀嚼力を比較したグラフである。それぞれ「何でも噛んで食べられる」と回答した者の割合のデータをプロットしてあるが、平均75.5歳の後期高齢者になっても東京オリンピアンの約８割が咀嚼良好者であり、同世代の一般高齢者に15ポイント以上の差をつけている。

このように、かつての一流競技者が70代になっても高いレベルの咀嚼力を維持しているのは残存歯数が多いことと、それらを支える歯周組織が健康な者が多いことがもたらした必然の結果であろう。

スポーツ心臓の生理的反応
―スポーツ心臓は可逆性変化である―

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●研究結果の概要

高強度のトレーニングを行っているエリートアスリートの心電図変化を調べる目的で、1964東京五輪選手365名に対して大会前に心電図検査を実施した。その結果を改編したものをTable1に示す(1)。全体の半数以上で左室肥大を認め、4割以上で洞性徐脈を認めた。各心電図所見は、男性の方が女性と比較して高い比率で確認された。

Table2には、心電図変化と競技生活との関連を評価するため、1964年と1976年の心電図を評価出来た男性競技者88名を対象として村山らが行った追跡調査の結果を示す(1)。

1964年に確認された心電図変化は、1976年の測定時にはその多くが消失していたが、左室肥大等の所見が一部の選手で残存していた。所見残存の比率に関しては、洞性徐脈と左室肥大は競技を継続している選手の方が、引退していた選手と比較して有意に高い比率であった。

これら88名のうち、競技引退から4年毎の心電図評価を12年後まで連続して行った32名について、心電図所見の推移を検討した。引退後の経過年数と心電図所見比率の推移を図1に示す。

現役時に指摘された心電図所見は、競技引退後の時間経過と共にその比率が低下したが、引退から12年後も不完全右脚ブロックと左室肥大は約2割での症例で残存していた。房室ブロックや洞性徐脈は、競技引退4年後には全員が消失していた。

本研究では、高強度トレーニングの心臓に対する影響を、心電図検査だけで無く、胸部レントゲン検査でも行った。

10名の競技者において、同検査を元にMoritz法(2)で算出した心陰影面積を、競技生活引退前と引退後12年間に渡って追跡した結果を図2に示す(1)。

現役競技者である時期には半数以上の競技者が心拡大を呈していたが、競技生活を引退した後、約4年から8年の経過で拡大していた心臓は縮小する傾向を認めた。最終的には、多くの選手が日本人における正常範囲内へ縮小していた。

エリートアスリートは、その競技に応じた動的・静的運動を行っている。本研究では競技種目による各所見の出現頻度は評価していないが、高強度のトレーニングにより生じたと考えられる洞性徐脈や房室ブロックは、競技生活の終了により消失していることが確認された。一方で、心電図もしくはレントゲン上で指摘された左室肥大や心拡大、心電図上の右脚ブロックは、引退から12年の経過後も一部の選手で残存していた。

このようなスポーツ心臓を呈していた競技者の長期的な経過を検討するため、約50年間の追跡調査が可能であった陸上長距離選手の一例を以下に示す。1968年と2016年の心電図・胸部レントゲン検査を提示しつつ、その所見を比較した。

Table 1.　1964東京五輪選手の心電図所見(1964年)

	男性(301名)	女性(64名)	全体(365名)
洞性徐脈	135名(44.9%)	20名(31.3%)	155名(42.5%)
左室肥大	192名(63.8%)	13名(20.3%)	205名(56.2%)
不完全右脚ブロック	15名(5.0%)	1名(1.6%)	16名(4.4%)
1度または2度房室ブロック	3名(0.1%)	0名	3名(0.1%)

Table 2. 男性アスリート(88名)に対する1964年及び1976年の心電図評価)

	1964年 (88名)	1976年	
		現役(14名)	引退後(74名)
洞性徐脈	45名 (51.1%)	2名(14.3%)	1名(1.4%)
左室肥大	66名(75.0%)	7名(50.0%)	16名(21.6%)
不完全右脚ブロック	5名(5.7%)	2名(14.3%)	2名(2.7%)
1度または2度房室ブロック	2名(2.2%)	0名	0名

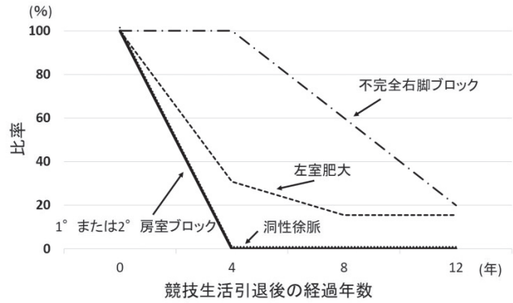

図1　競技引退後の経過年数と心電図所見の比率

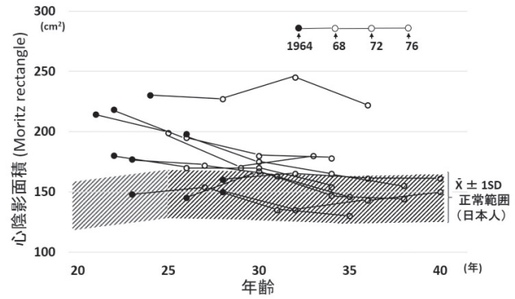

図2　Moritz法による心陰影面積と引退後経過年数の関係

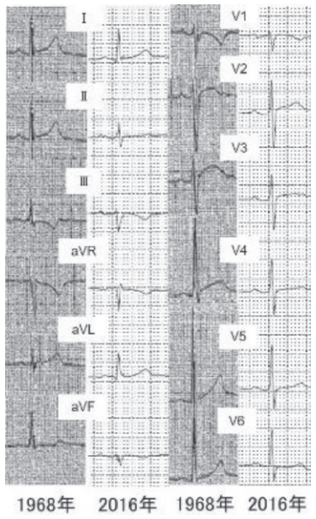

図3　心電図

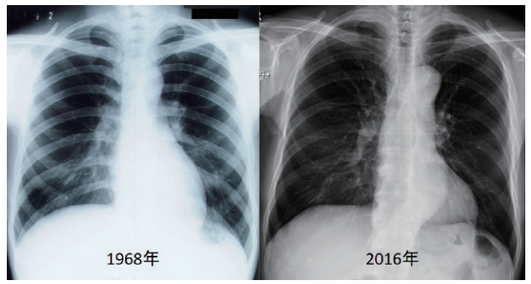

図4　胸部レントゲン写真

被験者は1968年の測定時にも現役で競技を継続し、2016年の測定時まで継続的に運動を行っていた。図3には1968年と2016年の心電図を示している。1968年時には不完全右脚ブロック、左室肥大の所見を呈していた。2016年ではそれらの所見は認めなかったが、左軸偏位の所見を認めた。図4には心電図と同様のタイミングで施行した胸部レントゲン写真を提示している。心陰影の横径と肺野横径の比率(心胸郭比)はそれぞれ41%と42%と殆ど差は認めなかったが、推定される心陰影面積は、1968年と比較して2016年の方が明らかに減少していた。また、2016年のレントゲンでは、胸郭内の心臓の位置(傾き)が1968年と比較して横になっている他、大動脈の蛇行を認めている。心電図の左軸偏位やレントゲンでの大動脈の蛇行については、被験者が高血圧を指摘されていることから、その影響が考えられた。

今回の研究結果から、エリートアスリートは高強度トレーニングの影響により電気生理学的・形態的変化を来すが、その多くは可逆性変化であり、競技生活の終了によって、その所見は正常化していた。

一般的に、エリートアスリートの寿命は全体の平均と比較して長いことがこれまでに報告されている(3)。しかし、その機序や、心電図所見が長期間持続した選手の長期的な影響については、まだまだ不明な点が多いため、今後のさらなる研究が望まれる。

（1）　Murayama M, et al, Cardiovascular Future of Athletes. J Physical Fitness Japan 1980; 29: 117-123.

（2）　Moritz F. Ueber die Norm der Groesse and Form des Herzens beim Mann. Deut. Arch, klin. Med. 1931; 171: 431-476.

（3）　Lemez S, et al. Do Elite Athletes Live Longer? A Systematic Review of Mortality and Longevity in Elite Athletes. Sports Med Open 2015; 1:16.

1964東京五輪選手と一般地域在住高齢者の比較からのフレイルの視点に立った新知見：1964東京五輪選手は高齢期も筋肉量や筋力が高いが、歩行速度の低下や筋骨格系の疼痛を有する傾向

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●1964東京五輪選手の身体能力は高齢期でも超一流なのか

1964年に開催された1964東京五輪選手の多くが高齢期を迎えている。彼らは超一流競技者であり、我が国における長いスポーツの歴史の中の英雄である。スポーツ競技種目の違いはあるものの、彼らの青壮年期の運動習慣により最大限高められた筋肉や筋力、そして身体能力は一般人のそれをはるかに凌駕していたことだろう。では、オリンピック代表選手に選ばれるほどのトップアスリートたちは高齢期になっても、一般人と比較して優れた身体能力を維持できているのだろうか。我々はこの疑問に答えるべく、1964東京五輪選手の長年にわたり蓄積されたデータと、一般の地域在住高齢者のデータを用いて、筋肉量や最大筋力、身体機能を比較してみたところ、驚くべき結果が得られたので報告する。

●どんなデータを比較したのか

我々は1964東京五輪選手を対象とした東京オリンピック記念体力測定の協力者の内、2016年度に実施された第13回実測調査に参加し、筋肉量などのデータをすべて取得した101名(平均年齢75.0±4.4歳、女性26%)のデータと、千葉県柏市に住む高齢者1,529名(平均年齢74.1±5.5歳、女性49%)のデータを用いて、生活習慣や栄養状態、身体能力、筋骨格系の疼痛、病歴などを比較した。さらに、我々はスポーツ競技の種目による違いや、引退後の運動習慣も大きく結果に影響すると考え、これらも調査しました。具体的には、アメリカ心臓病学会のオリンピックスポーツ種目における第8回タスクフォースの種目分類に従い、オリンピック研究の対象者の種目を３種類の運動強度(静的運動強度、動的運動強度、心肺運動負荷強度)でそれぞれ低、中、高強度で分類した(図１)。また、スポーツ競技中の身体的接触の強度をアメリカ小児学会の定義に基づき評価し、オリンピックスポーツ種目を身体的接触なし、限定的、接触ありの３群で評価した(図１)。1964年のオリンピック後の運動習慣は、４年おきに実施した自記式質問票調査のデータを用いて、50歳以前まで週１－２回以上の運動習慣の有無を評価した。

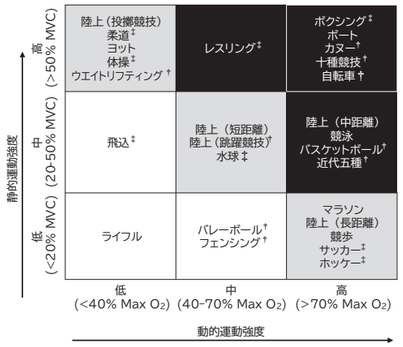

図１　オリンピック種目分類(運動強度および身体的接触の有無)
MVC, maximal voluntary contraction (最大随意筋力)
心肺運動負荷強度は低(白)、中程度(灰)、高(黒)の３段階で分類。†, ‡:身体的接触の有無による分類(†, 限定的な接触あり; ‡, 接触あり)

●1964東京五輪選手の高齢期までの病歴や生活習慣に差はあるのか

1964東京五輪選手と一般の高齢者の今までの病歴を比較すると、1964東京五輪選手の方が高血圧や糖尿病、心臓病、脳卒中の病歴を持つ人が、統計学的に意味のある差ではないものの、わずかに少ない傾向にあった。一方で、抑うつ傾向にある人は、むしろ1964東京五輪選手で多いこともわかった。生活習慣については、高齢期の運動習慣には差はなかったものの、食生活や飲酒・喫煙習慣には違いがみられた。具体的には、1964東京五輪選手は肉類や魚介類、卵、野菜、果物を少なくとも２日に１回は食べている割合が高かった。高齢期でも食事バランスの良い食生活は重要であり、特に身体をつくる源となるタンパク質を頻度高く摂取することが推奨されるが、この点において1964東京五輪選手の方が優れており、選手時代に培った身体づくりのノウハウが高齢期の健康的な食生活にも活きているのかもしれない。また、喫煙習慣においても1964東京五輪選手の方が、愛煙家がすくなかった。アルコール摂取頻度は1964東京五輪選手で多く、特に女性で差が顕著であった。

●1964東京五輪選手は高齢期でも筋肉量や最大筋力が高い

1964東京五輪選手と一般的な高齢者を比較すると、体格指数であるBMIには差がなかったが、四肢の骨格筋量や最大筋力(握力)は1964東京五輪選手の方が高いことがわかった。特に1964東京五輪選手女性選手は、一般の女性高齢者と比較して極めて高い四肢骨格筋量を保持していた(図２、３)。これは産まれもった体躯の違いによる部分もあるが、一般女性の若い世代からの運動習慣不足や低い筋肉量が高齢期の四肢骨格筋量を想像以上に低下させてしまっている可能性が考えられる。ところで、高齢期に多くみられる筋肉減弱症をサルコペニアと呼ぶ。サルコペニアは「転倒、骨折、身体機能低下、死亡などの健康障害の危険が高まった進行性かつ全身性の骨格筋疾患」と定義され、四肢骨格筋量の低下に、最大筋力や身体機能の低下が併存した状態と診断される。実は我々の解析結果から、四肢骨格筋量や最大筋力の高さがゆえに、1964東京五輪選手はサルコペニアの状態になっている人が少ないことがわかった。この四肢骨格筋量や最大筋力の高さは、特に50歳以降も運動習慣を継続していた選手や、高い運動強度の競技種目の選手ほど高い傾向であった。一方で男性では運動強度の低い競技種目の選手では、一般の高齢者と統計学的に意味ある違いがみられなくなってしまった。このことからも、高齢期のサルコペニアを防ぐためには、少なくとも適度な運動強度が必要であること、なるべく運動習慣を継続することが重要であるといえる。

●1964東京五輪選手は高齢期で筋骨格系の疼痛を持ちやすく、バランス能力・歩行速度がむしろ低い場合も

1964東京五輪選手と一般的な高齢者を比較すると、筋肉量や最大筋力が高いことがみとめられた。しかしながら、一方で1964東京五輪選手の方がバランス能力や歩行能力が一般の高齢者よりも低いといった逆転現象が起きていることもわかった。具体的には1964東京五輪選手のほうが、目を開けたまま片足で立っていられる時間が短く、歩く速度も低いことがわかった(図４)。さらに、筋骨格系の疼痛を質問票で伺うと、一般の高齢者よりも1964東京五輪選手の方が疼痛を持っている人が多く、痛みの程度も高かった(図５)。この傾向は、50歳前に運動習慣をやめた選手や、運動の強度が高く、身体的な接触を伴う競技種目の選手ほど顕著であった。これらは過剰なトレーニング等によるスポーツ障害に全て起因するとは言い切れないものの、老年期の身体機能の低下や慢性的な筋骨格系疼痛を引き起こす可能性があると考えられる。また、一般的に、慢性的な筋骨格系の痛みを持つ人の割合は加齢とともに増加することが知られており、また、高齢期の筋骨格系の痛みは日常生活活動の低下、抑うつ傾向の危険因子ともされる。よって、先に述べたような若い世代から高齢期にかけての身体機能の向上は重要だが、怪我やスポーツ障害の予防・対策がアスリートの長い人生に大きな影響を及ぼす可能性が考えられる。

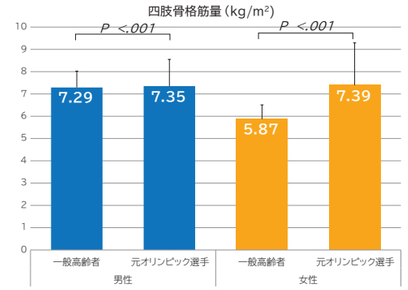

図２　1964東京五輪選手と一般高齢者の四肢骨格筋量(kg/m^2)の平均値(標準偏差)比較

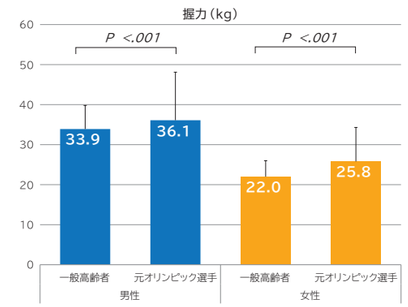

図３　1964東京五輪選手と一般高齢者の握力(kg)の平均値(標準偏差)比較

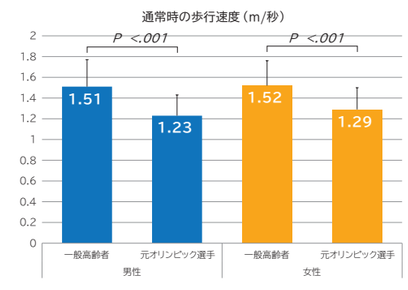

図４　1964東京五輪選手と一般高齢者の通常の歩行速度(m/秒)の平均値(標準偏差)比較

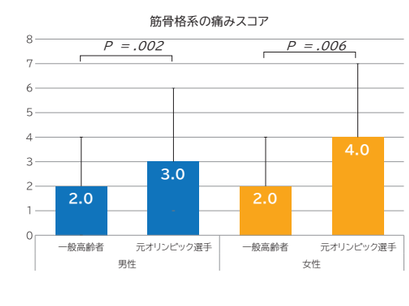

図５　1964東京五輪選手と一般高齢者の筋骨格系の痛みスコアの中央値(四分位範囲)の比較
※痛みスコアは高いほど、筋骨格系の疼痛が強い

●まとめ

我々は我が国の1964東京五輪選手と千葉県柏市在住の一般地域高齢者を比較してみた。結果として、1964東京五輪選手では四肢の骨格筋量や最大筋力が優れており、その後の運動継続の重要性も確認できた。これらは、青年期の段階から、健康的かつ活動的な生活習慣の基盤が確立され、高齢期の生活習慣に好影響を与えたことや、早期に高められた筋肉量や筋力と相まって、高齢期にも持ち越されたのではないかと考えられる。一方で、1964東京五輪選手では筋骨格系の疼痛を持っている人が多く、身体能力がむしろ低いことが明らかとなった。1964年から57年後の2021年、改めてオリンピックが東京で開催される。1964年のアスリート達からの人生をかけた学びを活かすためにも、高齢期のサルコペニア予防に向けて、青年期以降の運動継続をより推進すると共に、特にスポーツ競技者の怪我予防等に対するより一層の教育的介入や環境改善が求められる。なお本研究の成果をまとめた論文は、学術的な国際誌(Journal of Cachexia, Sarcopenia, and Muscle)に掲載された。

オリンピック出場選手は長生きなのか？

～1964東京五輪選手の生命予後について～

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●研究結果の概要

1964東京五輪選手手355名(男295名、女60名)について、2017年12月31日時点で把握できた生存・死亡情報および体力測定データを用いて死亡をアウトカムとする生存時間解析および多変量解析を行った。東京オリンピック記念体力測定で転帰が不明であった選手については、インターネット上の公開情報等も利用し、計342名(男283名、女59名)を解析対象とし、総観察人年は15974.8年となり、平均観察期間は約47年間であった。

わが国の人口動態統計(1950～2015年)による５年毎の性・年齢階級別死亡率を用いた標準化死亡比(Standardized Mortality Ratio, 以下SMR)の算出により、一般人との比較による生命予後評価を行った。全体のSMRは0.64(95%信頼区間：0.50, 0.81)と推計され、一般に比べ死亡率が約４割程度低い、すなわち1964東京五輪選手は長生きであることが示された。

次に、死亡率との関連要因について、初回および第１回(1964年および1968年)の体力測定データを用いて、出場競技種目の運動強度カテゴリ、五輪総出場回数、生活習慣(喫煙歴、肥満指数カテゴリ：BMI<23、23～25、25<BMI)等を共変量とする多変量解析(Cox比例ハザードモデル)を行い、コホート内における比較検討を試みた結果、BMIが23kg/m^{2}未満の群を基準(＝１)とした場合、BMIが25kg/m^{2}以上の群ではハザード比が3.18(95%CI:1.34, 7.55)、すなわち約３倍のハイリスクであることが有意に示された。また、総出場回数が多いほど死亡率が高くなる傾向もみられ、統計学的な有意性は示されなかったものの、戦後の歴代オリンピック出場選手を追跡した我々の先行研究の結果(Takeuchi. et al. 2019)と矛盾はないものと思われる。さらに、死亡率と引退後の運動習慣の関連について調べた結果、運動習慣が「まったくない」もしくは「ほとんどない」と回答した群に比べ、「１～２回／月(頻度)」から「競技レベル」程度の運動習慣がある場合は約２割程度の死亡リスク低下(HR; 0.78～0.83)がみられたが、統計学的有意性は示されなかった。

一般の地域住民を対象とする健康調査では、40歳以降を対象に生活習慣による影響を調べる目的で行われるものが大半である。一方、1964東京五輪選手の場合は、平均年齢が23歳前後であり、極めて若いコホートを対象としている点も考慮する必要がある。死亡リスクを増大させる要因には、肥満などとは異なる、別の要因が関与している可能性も否めない。

一般に、運動習慣は心血管系疾患、高血圧およびがんといった生活習慣病の予防に有効なことから、アスリートは長生きであることに異論を唱える人は少ないと思われるが、オリンピック出場選手のように長期間にわたって過度なトレーニングや高強度運動、著しい食事制限、筋肉増強剤の使用などに晒された集団における疾病リスクや死亡率への影響は殆ど調べられていない。今後は、すべてのオリンピック出場選手を生涯にわたって追跡できるような体制と貴重なデータベースを管理運用できるしくみが整備されることを願って止まない。

●解析対象者の内訳(表１－１、１－２)：

1964東京五輪選手355名(男295名、女60名)について、生死情報または死亡年月が不明の者を除いた342名のうち、70名(男64名、女６名)が死亡と確認された。表１－１は、死亡者数およびその割合を競技別に示したものである。解析した時点で死亡者数が最も多かったのは陸上競技の12名であったが、出場選手に占める死亡者数の割合が最も高いのは柔道(50%)であった。表１－２は、1964年の初回体力測定(ベースライン)時点のデータを示す。

表1－1　（競技別生死情報の内訳）

競技名	出場者数	死亡確認者数(%)
陸上競技	67	12 (17.9)
水泳	58	9 (15.5)
バレーボール	24	7 (29.2)
ボート	23	4 (17.4)
サッカー	19	7 (36.8)
ホッケー	16	3 (18.8)
レスリング	15	4 (26.7)
自転車	15	2 (13.3)
フェンシング	15	1 (6.7)
体操	14	1 (7.1)
セーリング	12	2 (16.7)
カヌー	12	2 (16.7)
バスケットボール	11	3 (27.3)
ボクシング	9	3 (33.3)
馬術	9	3 (33.3)
ライフル射撃	8	2 (25)
ウエイトリフティング	7	3 (42.9)
柔道	4	2 (50)
クレー射撃	2	0 (0)
近代五種	2	0 (0)
合計	342	70

表1－2　（初回体力測定時の生活習慣要因における分布）

	男	女	
	n; 283	n; 59	不明, n (%)
年齢 (mean ± SD)[歳]	23.8 ± 3.8	22.3 ± 4.7	3 (0.9)
肥満係数 BMI, n (%)			
<19 [kg/m^2]	11 (3.9)	5 (8.6)	4 (1.2)
19-<21 [kg/m^2]	55 (19.6)	16 (27.6)	
21-<23 [kg/m^2]	107 (38.2)	17 (29.3)	
23-<25 [kg/m^2]	70 (25)	18 (31)	
≥25 [kg/m^2]	37 (13.2)	2 (3.4)	
喫煙, n (%)			
まったく吸わない	104 (52)	44 (92)	95 (27.8)
たまに吸う	30 (15)	1 (2)	
毎日	65 (33)	3 (6)	
握力区分, n (四分位範囲 [kg])			
Q1；第１四分位	73 (33.0-48.5[kg])	15 (27.3-32.5[kg])	15 (4.4)
Q2；第２四分位	66 (48.5-53.0[kg])	13 (32.5-35.1[kg])	
Q3；第３四分位	66 (53.0-58.3[kg])	16 (35.1-38.0[kg])	
Q4；第４四分位	66 (58.3-80.5[kg])	12 (38.0-49.5[kg])	
飲酒, n (%)			
まったく飲まない	64 (32)	35 (73)	93 (27.2)
機会飲酒	105 (52)	12 (25)	
毎日	32 (16)	1 (2)	

表2（観察期間別・経過年数別SMR）

	総観察人年	死亡数	期待死亡数	SMR (95% CI)
観察期間(年)				
1964-1997	10696.74	24	32.01	0.75 (0.49-1.10)
1998-2007	3049.08	23	32.67	0.70 (0.46-1.04)
2008-2017	2704.75	23	58.82	0.39 (0.25-0.58)
経過年数(年)				
0-10未満	3395.22	4	5.49	0.73 (0.23-1.76)
10-20未満	3341.92	6	7.66	0.78 (0.32-1.63)
20-30未満	3272.19	10	15.40	0.65 (0.33-1.16)
30以上	6441.23	50	94.96	0.53 (0.40-0.69)

表3（各曝露要因と死亡リスクの関連）

	該当者数 (%)	総観察人年	死亡数	調整済みハザード比 (HR)		
				HR	95% CI	P for trend
総出場回数（回）						
1	228 (66.67%)	11174.03	43	Ref		0.727
2	86 (25.15%)	4105.45	20	1.18	0.55-2.55	
3以上	28 (8.19%)	1179.98	7	1.14	0.32-4.06	
運動強度(動的)						
low	76 (22.22%)	3591.58	16	Ref		0.352
middle	73 (21.35%)	3548.05	16	1.69	0.67-4.25	
high	173 (50.58%)	8353.44	35	1.61	0.63-4.09	
不明	20 (5.85%)	966.39	3			
喫煙歴						
なし	149 (43.57%)	7339.65	25	Ref		0.786
あり	99 (28.95%)	4834.42	18	1.1	0.57-2.12	
不明	94 (27.49%)	4285.39	27			
BMI						
23未満	211 (61.70%)	10147.77	39	Ref		0.017
23以上25未満	88 (25.73%)	4399.8	13	1.28	0.6-2.75	
25以上	39 (11.40%)	1743.15	16	3.18	1.34-7.55	
不明	4 (1.17%)	168.74	2			

表4（競技出場後の運動習慣と死亡リスクの関連）

	総観察人年	死亡者数	調整済みハザード比		
			ハザード比	95%信頼区間	P値
運動習慣					
ほとんど(全く）やっていない	1549.0	6	Ref		0.802
月１- ２回程度・週１- ４回程度	3941.8	16	0.78	0.28-2.14	
競技的	6008.6	25	0.83	0.31-2.20	
欠測	3676.8	23			

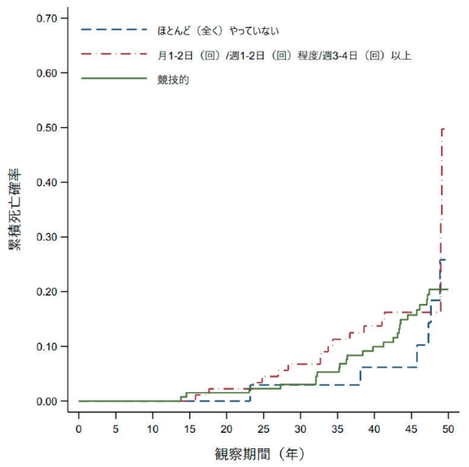

図１　1968年(第１回)調査時の運動習慣で層別化したカプランマイヤー曲線

●標準化死亡比 SMR: Standardized Mortality Ratioによる対一般人口比較の結果(表２)：

わが国の人口動態統計(1950～2015年分)における５年毎の性別および年齢階級別死亡率を用いて、観察期間別および1964年の大会出場時からの経過年数別にSMRを算出した(表２)。時代背景による違いを考慮し、おおよその観察死亡数が均等になるよう観察期間を３区分し、経過年数については４カテゴリに分けて分析を行った。観察期間別のSMRでは、最も近い年代(2008～2017年)において有意に死亡率が低下していた。経過年数別のSMRでは、30年以上経過群での死亡率の低下が有意に示された。

●Cox比例ハザードモデルによる死亡関連要因の検討(表３)：

死亡をアウトカムとする多変量解析の結果を表３に示す。総出場回数が１回の選手に比べて複数回出場した群では死亡リスクが増す傾向がみられたが、統計学的有意性は示されなかった。同様に、競技名による運動強度別のハザード比では、低強度に比べて中等度～高強度競技群で死亡リスクが増す傾向がみられたが統計学的有意性は示されなかった。肥満指数とされるBMIについては、25 kg/m^{2}以上の群でのみ約３倍のリスク増大となることが統計学的有意を以って示された。

●ベースライン時点(初回体力測定)における運動習慣と死亡リスク(図１、表４)：

図１に1968年時点での運動習慣(アンケート)により層別化したカプランマイヤー曲線を示す。運動習慣を「ほとんど(まったく)ない」、「月１～２回程度もしくは週１～４回程度」、「競技レベル」の３群に分類した。ログランク検定において有意差は示されなかった(p=0.99)。表１に、Cox比例ハザードモデルによる調整済みハザード比を示した。運動習慣に関するデータの欠測が多いため、統計学的な有意性は示されなかったが、運動習慣が「ほとんど(まったく)ない」群に比べ、「月１～２回程度もしくは週１～４回程度」および「競技レベル」群では、約２割程度の死亡リスク減少がみられた。

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1964東京五輪選手の体力や体重変化が現役引退後の健康状態に及ぼす影響

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●研究結果の概要

- 1964東京五輪選手を対象に、オリンピック参加時の全身持久力と現役引退後の高血圧発症の関係を明らかにするために、オリンピック参加時の全身持久力と2016年まで追跡した追跡期間中の高血圧発症率の関係を調査した。
- 調査の結果、トップアスリートにおいても、一般人を対象にした研究で報告されている結果と同様に、低い全身持久力は高血圧発症の危険因子であることが確認された。
- さらに、オリンピック参加時の体重とオリンピック参加後８年もしくは12年後の体重を比較し、体重の変化別に高血圧および糖尿病発症率の関係を調査した。
- 調査の結果、オリンピック参加後に体重が増える割合が大きかった選手ほど高血圧および糖尿病発症率が高い傾向にあり、トップアスリートであっても現役引退後に体重が増加した場合は体重を維持している人と比較して高血圧や糖尿病を発症しやすいことが確認された。

●1964東京五輪選手の体力と現役引退後の高血圧発症率の関係

体力のなかでも健康と最も関係が深い体力は全身持久力だということが知られている。オリンピック大会参加選手であっても、実施する種目や個人のトレーニングレベルによって全身持久力にばらつきがあると考えられる。そこで本研究はトップアスリートの全身持久力と高血圧の関係を明らかにするために、1964年東京オリンピック参加時の全身持久力と、2016年まで追跡した追跡期間中の高血圧発症率の関係を調査した。

（１）調査方法

本研究の解析対象者は、1964年に実施した第１回東京オリンピック記念体力測定において全身持久力を測定し、2005年、2008年、2012年、2016年の記念体力測定に１度以上参加した156人である。そして、この156人を全身持久力測定の結果で、「全身持久力が相対的に低い群」「平均的な全身持久力の群」「全身持久力が相対的に高い群」の３群に分類した。そして、追跡期間中に各群の高血圧発症状況を確認した。

（２）調査結果

「全身持久力が相対的に低い群」を基準にして、「平均的な全身持久力の群」と「全身持久力が相対的に高い群」の相対危険度を計算した。その結果、「平均的な全身持久力の群」は、「全身持久力が相対的に低い群」と比較して25%低い相対危険度であった。また、「全身持久力が相対的に高い群」は、「全身持久力が相対的に低い群」と比較して41%低い相対危険度であり、全身持久力が高いほど高血圧発症の危険度が低い値を示していた(図１)。これらの結果から、トップアスリートにおいても、一般人を対象にした研究で報告されている結果と同様に、低い全身持久力は高血圧発症の危険因子であることが確認された。

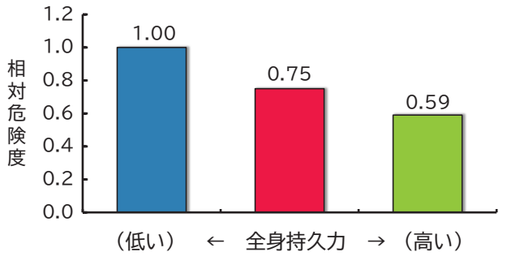

図１　全身持久力別にみた高血圧発症の相対危険度

●1964東京五輪選手の現役引退後の体重変化と高血圧および糖尿病発症率の関係

肥満はさまざまな健康問題と関連があり、肥満は世界における健康上の大きな課題となっている。オリンピックに参加したトップレベルのスポーツ選手においてもオリンピック参加後の現役引退や練習量の低下など環境の変化に伴う体重の変化が健康に影響を及ぼす可能性がある。そこで本研究はオリンピック出場後の体重変化が高血圧および糖尿病発症にどのような影響を与えるかを明らかにするために、1964年東京オリンピック参加時の体重がオリンピック参加後８年もしくは12年後にどのくらい変化したかを確認し、体重変化量とその後の高血圧および糖尿病発症の関係を調査した。

（１）調査方法

本研究の解析対象者は1964年に実施した第１回東京オリンピック記念体力測定において体力を測定し、2005年、2008年、2012年、2016年の記念体力測定に１度以上参加して血圧測定と血液検査を受けた109人である。第１回東京オリンピック記念体力測定における体重を基準に、オリンピック参加後、８年(1972年)もしくは12年(1976年)の体重との差を求め、「体重が減った群」「体重がやや増えた群」「体重が大幅に増えた群」の３群に分類した。そして、追跡期間中に実施した血圧測定や血液検査によって各群の高血圧や糖尿病の発症状況を確認した。

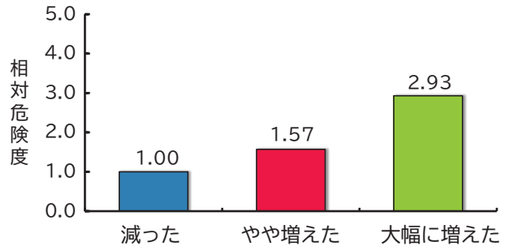

図２　体重変化量別に見た高血圧発症の相対危険度

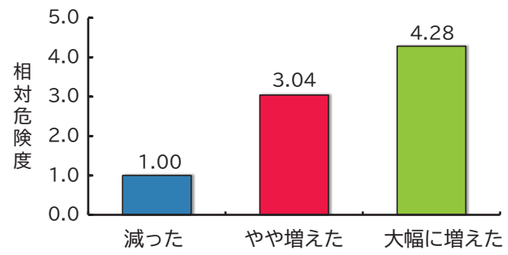

図３　体重変化量別に見た糖尿病発症の相対危険度

Changes in State of Physical Fitness and Engagement in Exercise/Sports in Athletes Who Represented Japan at the TOKYO1964 Olympians

Yasunori Morioka[1], Soya Ishizuka[2], Hiroshi Aono[2], Shizuo Ito[3]

1) Nihon University; 2) Japan Sport Association; 3) Tokyo Marathon Foundation

●Overview of study results

- Differences between the TOKYO1964 Olympians and Average Japanese in terms of strength, power, and agility tended to remain nearly constant until old age, but no clear differences between the two groups in the tendency for these to decline with age were observed.
- Individual differences (deviations) were great in terms of flexibility and balance, and a tendency for these to be worse in the TOKYO1964 Olympians than in Average Japanese was also observed.
- The ratio of both male and female of the TOKYO1964 Olympians who engage in exercise/sports at least once a week trended higher than that of Average Japanese from adolescence to middle age, but this difference with Average Japanese tended to gradually lessen as the athletes grew older.

●Physical fitness

About 20% of the total number of samples of male TOKYO1964 Olympians had lower strength (grip strength measured from the first through to 13th measurements) than Average Japanese (Society for Physical Fitness Standards Research in Tokyo Metropolitan University, 2007). However, almost all of the women far exceeded Average Japanese, and strength tended to be higher on average than Average Japanese in both male and female athletes. Also, strength in both male and female TOKYO1964 Olympians gradually declined starting from about age 30, and this downward trend with aging was similar to that of Average Japanese (Fig. 1). This tendency also held true for back strength measured from the first through ninth measurements.

In addition, power (vertical jump) decreased linearly with age for both the TOKYO1964 Olympians and Average Japanese, but the difference between the two tended to be maintained until old age (Fig. 2). Since the same tendency was also observed in agility (repeated horizontal jump), this can be said to suggest that the “carry-over effect” (Fig. 3) of the physical fitness element that had been heightened during adolescence can also be expected for power and agility in the same way as for strength.

Note that flexibility (standing-type body anteflexion, long seat-type body anteflexion) and balance (standing on one leg with eyes closed; standing on one leg with eyes open) deviated greatly for both men and women, and it was not possible to identify fixed trends including changes with age, such as most of the TOKYO1964 Olympians exhibiting lower values than Average Japanese. Changes in balance with age are said to be conspicuous especially among functional items, but it seems necessary to include such factors as aging mechanisms in balance functions and the influence of lower limb alignment when considering this point.

●State of engagement in exercise/sports

The ratio of individuals who engaged in exercise/sports

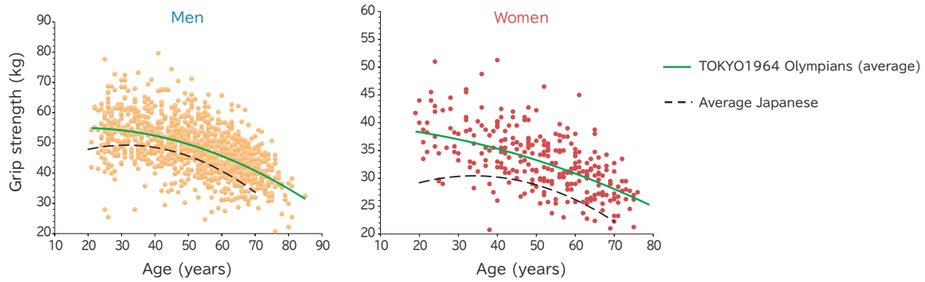

Figure 1: Strength (grip strength)

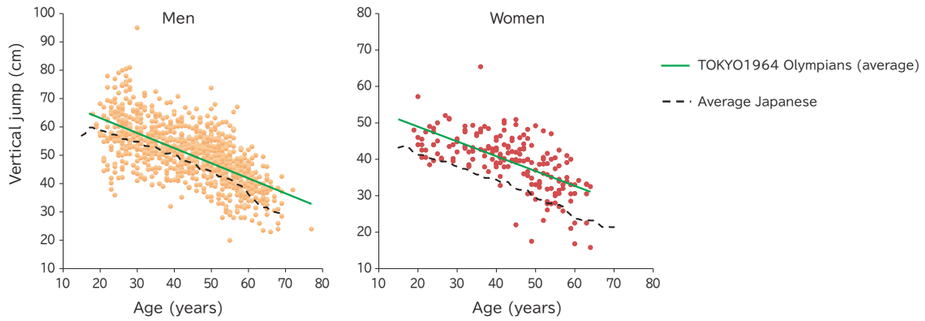

Figure 2: Power (vertical jump)

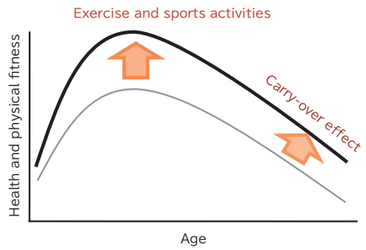

Figure 3: Carry-over effect on health and physical fitness (schematic)

(hereinafter, “the active”) more than once per week at the time of the fourth measurement (men 40.3 years old; women 38.4 years old) after the end of the TOKYO1964 when most of TOKYO1964 Olympians are thought to have ceased active competition was 56.1% for the male athletes and 72.7% for the female athletes, which was much greater than for Average Japanese, which for men in their 40s was 34.3% and for women in their 30s was 30.2% (Fig. 4: this data for Average Japanese used for comparison was obtained by referencing the data for the same time period and generation in the "Public Opinion Survey on Physical Fitness and Sports" by the Prime Minister's Office, Cabinet Office, and Ministry of Education, Culture, Sports, Science and Technology and "Public Opinion Survey on State of Engagement in Sports, Etc." by the Japan Sports Agency).

From their 40s to their mid-50s (men at 56.4 years old and women at 54.5 years old at time of the eighth measurement), the male TOKYO1964 Olympians went from 56.1% to 45.6% and the women from 72.7% to 56.0%, demonstrating a decline in both sexes, but these figures were as ever higher than those of Average Japanese (32.3% for men in their 50s and 41.7% for women). After that, until the 13th measurement (men at 76.0 years old and women at 73.5), both male and female TOKYO1964 Olympians showed an increase or decrease to about 60% (i.e., remained at a high level), but after around the age of 70 the ratio in Average Japanese was slightly higher.

●Conclusion

Opinions concerning whether there is a relationship between past exercise habits and current health and physical fitness are varied, but it also has been pointed out that there is a moderate correlation between past exercise experience and current exercise habits (Suzuki and Nishijima, 2005). The “carry-over effect” apparent in elements of physical fitness such as grip strength in the TOKYO1964 Olympians is presumed to be attributable to their higher rates of engagement in exercise/sports following retirement from active competition through the prime working years of middle age until reaching old age in comparison with Average Japanese. It has been pointed out in many domestic and international studies that grip strength is highly correlated with strength in many parts of one's entire body and is also associated with both overall and causal mortality as well as disease risk. The fact that exercise/sports habits and physical fitness factors from adolescence have been carried over to middle and old age while producing synergistic and cyclical effects suggests the possibility that the TOKYO1964 Olympians were more confident in their own health and physical fitness compared to Average Japanese, and this also relates to such matters as their tendency to have low rates of certification for nursing care (Japan Sports Association, 2016).

Therefore, it can probably be said that establishing exercise and sports practices in childhood and adolescence and habituating them throughout life is one of the necessary elements for living a healthy and prosperous life even through middle and old age.

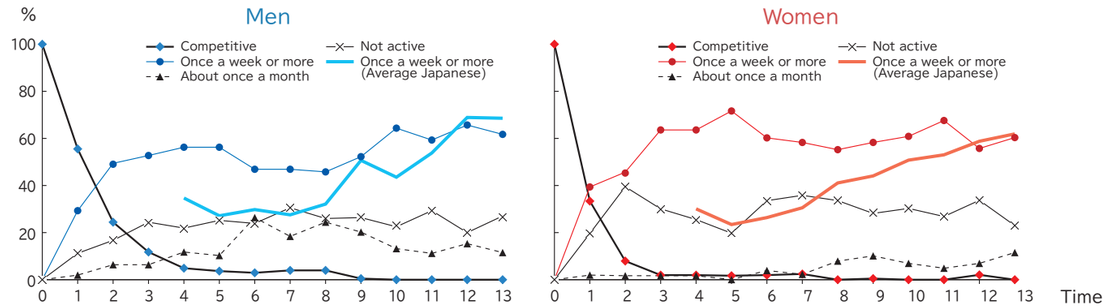

Figure 4: Changes in state of engagement in exercise/sports

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Orthopedic Evaluation of Motor Organs
(Bone Mineral Density, Lumbar Spine/Knee Joint Pain, Degenaration and Locomoter Function)

Kohei Nakajima[1)], Atsuto Hoshikawa[2)], Mika Hangai[1)], Toru Okuwaki[1)]

1) Japan Institute of Sports Sciences; 2) Saitama Medical Center

●Overview of study results

- We conducted a study of the bone mineral densities(BMD) as well as symptoms and changes in the locomotor organs of TOKYO1964 Olympians and were thought to have been exposed to high exercise load environments while young.
- The percentage of the athletes who **"experience pain"** in the lumbar spine and knee joints, which are typical locomotor organs, increased over time, and at the time of the 2016 (13th) survey when the average age of the athletes was 75.5 (average ages of men and women were 73.9 and 76.1, respectively), 48.5% (48.1% and 50.0% of the men and women, respectively) of the athletes experienced pain in the lumbar spine, and 40.6% (35.4% and 51.9% of the men and women, respectively) of the athletes experienced pain in the knee joints (Figure1, 2).
- Progression of **"osteoarthritis(OA)"** (Kellgren-Lawrence Classification Grade 2 or worse) in the lumbar spine and knee joint with time was evident even in simple radiography-based evaluations; 90.6% (91.4% and 88.9% of the men and women, respectively) of the athletes presented with OA in the lumbar spine and 50.9% (44.3% and 70.3% of the men and women, respectively) of the athletes presented with OA in the knee joint. However, it seems that their locomotor organs had been able to maintain a high level of functioning even while the athletes sensed pain and dysfunction in said organs.
- **"Bone Mineral Density; BMD"** was maintained at extremely high values compared to the average values of healthy young adults, and this was found to correlate with muscle strength and muscle mass.
- Based on the above, while it appears that a sufficiently high-load exercise environment during youth causes age-appropriate changes and symptoms in the motor organs, motor organ functioning and bone density can be maintained at high levels mainly due to muscle mass and muscle strength accumulated during youth.

●Characteristics of locomotor organs in the elderly

Locomotor organs are the only body organs that people can use at their will to move their body. However, it is known that upon reaching old age, various changes and impairments manifest in the structures and functioning of locomotor organs. For this reason, treatment of the osteoporosis that causes vulnerable fractures and exercise therapy for maintaining motor function are recommended as approaches for dealing with locomotor disorders in the elderly.

Also, it is said that the locomotor organs of the elderly are impacted by the past lifestyles and habits of individuals, and physical fitness measurements and medical checks of the TOKYO1964 Olympians thought to have had sufficient exercise loads and exercise habits while young have been conducted every year in the 52 years from the year in which the TOKYO1964 were held through 2016. These surveys can now be said to be valuable data on the locomotor organs of the elderly, and herein follows a description of the evaluations of the functioning and joints of the lumbar spine and knee, which are typical locomotor organs, as well as whole body BMD based on the results of the physical fitness measurements and medical checks conducted in 2016 (13th survey). Incidentally, the average age of the athletes who had represented Japan in the TOKYO1964 at the time of the 2016 survey was 75.5 (76.1 and 73.9 for women and men, respectively).

●Joint pain

We investigated the presence or absence of persistent pain in the lower back and knee joints at the time of each survey.

(1) Lower back pain (Fig. 1): The percentage of the athletes who responded that they "currently have persistent lower back pain" was 28.0% (28.1% and 29.1% for men and women, respectively) at the time of the 10th survey (with an average age at the time of the survey of 64.9) conducted in 2005, but afterwards this gradually increased and by 2016 (13th survey) 48.5% (48.1% and 50.0% for men and women, respectively) were experiencing lower back pain. Meanwhile, in surveys targeting the general population, it is said that there is little change with age from age 50, and the percentage of people who experienced lower back pain was approximately 30% (28.3% and 31.2% for men and women, respectively)[2)].

(2) Knee joint pain (Fig. 2): The percentage of the athletes who responded that they "currently have persistent knee joint pain" was 17.3% (17.2% and 34.5% for men and women, respectively) in 2005 (10th survey), but as was the case for lower back pain this had increased by 2016 (13th survey) to 40.6% (35.4% and 51.9% for men and women, respectively). In surveys targeting the general population, the incidence of this in those age 60 or older is 32.8% (24.1% and 37.6% for men and women, respectively)[3)], and a comparison of these shows that, considering the increases attributable to age, there seems to be no major difference between them.

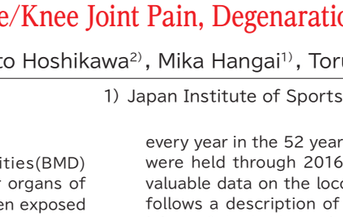

Figure 1: Presence/absence of lower back pain at time of survey (respective averages for men and women)
※Ratio of general population (age 50 or older) with lower back pain is 30% (28.3% and 31.2% for men and women, respectively)[2)] (Muraki et al., 2012)
※※Ratio of general population (60s and 70s) with lower back pain[5)] (Yoshimura et al., 2014)

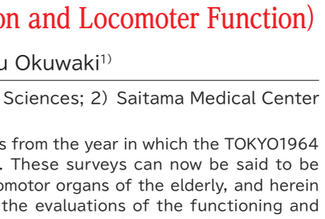

Figure 2: Presence/absence of knee pain at time of survey (respective averages for men and women)
※Ratio of general population (age 60 or older) with knee pain is 32.8% (24.1 % and 37.6% for men and women, respectively)[2)] (Muraki et al., 2012)
※※Ratio of general population (60s and 70s) with lower back pain[5)] (Yoshimura et al., 2014)

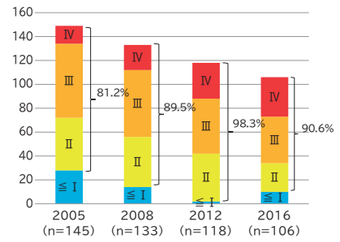

Figure 3: Ratio of lumbar spondylosis severity (K-L classification ≥ Ⅱ) at time of each evaluation

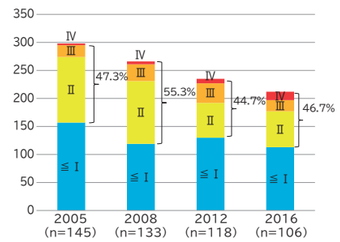

Figure 4: Ratio of gonarthrosis severity (K-L classification ≥ Ⅱ) at time of each evaluation

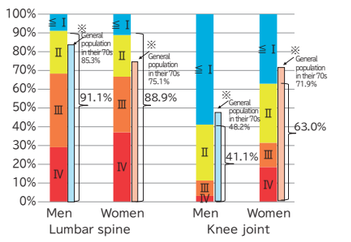

Figure 5: Ratio of OA (in lumbar spine/knee joint) severity at time of 2016 evaluation
※Ratio of general population (60s and 70s) with lower back pain[5)] (Yoshimura et al., 2014)

●Degenerative change of the joint

In the evaluations of the joints, radiography of the knee joint and lumbar spine (anterior-posterior/lateral) has been performed since the 4th survey (1980), and from the 10th survey (2005), joints have been evaluated using a 5-level evaluation (0 to IV) based on the Kellgren-Lawrence (K-L) classification[4)] that is widely used to evaluate the severity of OA.

(1) Osteoarthritic changes in the lumbar spine (Fig. 3): The ratio of athletes who presented with changes attributable to OA of Grade 2 (mild) or worse under the K-L classification was 81.2% in 2005, but it had increased to 90.6% (91.1% and 88.9% for men and women, respectively) (Fig. 5) at the time of the evaluation in 2016.

(2) Osteoarthritic changes in the knee joint (Fig. 4): The ratio of athletes who presented with findings of mild or worse (K-L>II ; same level OA severity of the lumbar spine) OA in 2005 was 47.3%, but this did not change significantly by 2016 when it was 46.7% (41.1% and 63.0% for men and women, respectively). However, the ratio of athletes with severe symptoms seems to have increased, and 6 of them (all women) had undergone knee replacement surgery, etc. There was a difference between men and women with respect to the knee joint, with the changes in the joints of women describable as more conspicuous (Fig. 5). Compared with the reports[5, 6)] on surveys targeting members of the general population of the same generation as the Tokyo athletes, changes attributable to OA were slightly more pronounced in the lumbar spine and slightly less in the knee joint, but there seems to have been no major difference.

●Locomotor organ function

The Japanese Orthopaedic Association posits that the overall decline of locomotor functioning in the elderly is a "Locomotive Syndrome" and has developed a locomotive syndrome test that uses locomotor function (stand up test/2-step test) and subjective symptoms (25-question Geriatric Locomotive Function Scale) as an index for evaluating said decline. This test divides severity into two levels, and when implemented for the athletes representing Japan in the TOKYO1964, the ratio of athletes who did not meet the standards for either locomotive syndrome level 1 or 2 in any test (i.e. locomotive syndrome level 0) was 46.1% when tested for subjective symptoms (using the 25-question Geriatric Locomotive Function Scale). In contrast with this, however, the ratios were very high when tested using the stand up test (66.0%) and 2-step test (78.4%) that can be described as motor function evaluations, and it seems that a high level of locomotor function had been maintained in comparison to when evaluated using subjective symptoms (Fig. 6).

●Bone Mineral Density

BMD(whole body) has been evaluated since the 8th survey (1997), but because the measurement instruments differed in the various times when measurements were conducted, it is difficult to make a simple comparison of changes over time. Throughout all the measurements of BMD, none of the male or female athletes had a BMD of less than 70% of the average value of bone mass for young people (ages 20 to 44; young adult mean, or YAM), and no athletes had clinically diagnosable osteoporosis (Table 1).

The body measurement values (body length, body weight, BMI, and grip strength) of the TOKYO1964 Olympians were compared to the values7) for members of the age matched general public in order to investigate the reasons why BMD had been maintained at a high level, and while maintaining standard BMI, the athletes had greater body length and body weight except for some age groups, with grip strength in particular being superior in all age groups, and it seems that the athletes representing Japan in the TOKYO1964 enjoyed superior physiques, with a great deal of muscle mass (Table 2). Also, a positive correlation was observed between BMD, muscle mass, and grip strength, and the greater the muscle mass or grip strength, the higher the BMD (Fig. 7).

However, we were unable to find any significant association between current exercise habits and muscle mass, grip strength, or BMD, and at the very least it seems likelier that exercise load and habits when young were what affected muscle mass, grip strength, and BMD rather than current exercise habits (Fig. 8).

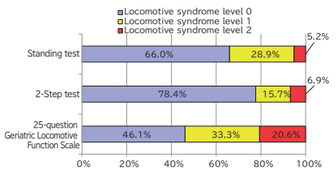

Figure 6: Distribution of locomotive syndromes in subjects in each locomotive syndrome test

Survey when implemented (year)	Measurement method	Men		Women	
		Average (minimum value /maximum value)	YAM≦ 80	Average (minimum value /maximum value)	YAM≦ 80
8th survey (1997)	Quantitative ultrasound (QUS) method	90.30% (71.0-113.0)	13(12.1%)	92.60% (77.0-135.0)	2(7.4%)
9th survey (2001)	Quantitative ultrasound (QUS) method	93.80% (74.0-118.0)	9(8.0%)	96.20% (78.0 -147.0)	2(8.0%)
10th survey (2005)	DEXA法 (骨塩)	97.00% (78-118.7)	3(2.5%)	88.80% (75.6 -107.5)	4(13.8%)
11th survey (2008)	DEXA法 (骨塩)	96.40% (75.0-117.3)	2(2.0%)	86.50% (75.5 -101.7)	4(14.3%)
12th survey (2012)	DEXA法 (骨塩)	106.60% (81.0-127.0)	0(0.0%)	94.40% (82.0 -118.0)	0(0.0%)
13th survey (2016)	DEXA法 (骨塩)	104.80% (80.0-125.0)	0(0.0%)	96.50% (81.0 -123.0)	0(0.0%)

Table 1: Comparison with young adult mean (YAM) BMD(whole body)
※, ※※ : By measurements with the same instrument type

Sex	Age	n	Body length (cm)		Body weight (kg)		BMI		Grip strength (kg)	
			TOKYO1964(for comparison)*		TOKYO1964(for comparison)*		TOKYO1964	TOKYO1964(for comparison)*		TOKYO1964(for comparison)*
Men	65-69	19	170.3	*166.7*	69.7	*64.4*	23.9	40.9	*40.2*	
	70-74	45	169.6	*164.8*	70.4	*62.4*	24.5	39.9	*38.1*	
	75-79	18	169.3	*163.2*	67.8	*61.4*	23.6	37.9	*35.7*	
	80≦	6	162.4		57		21.6	31.4		
(Average)			**169.2**		**68.8**		**24.0**	**39.1**		
Women	60-64	1	149.7	*155.5*	48.4	*53*	21.6	31.8	*26.6*	
	65-69	11	163.3	*153.7*	58.9	*52.3*	22	29.9	*25.3*	
	70-74	10	157.4	*152*	57.6	*51.1*	23.1	28.4	*23.9*	
	75-79	6	160	*150.6*	56.1	*50.2*	21.9	25.1	*22.8*	
(Average)			**160.0**		**57.5**		**22.4**	**28.6**		

Table 2: Comparison of physiques (body length, body weight, BMI) and grip strength of athletes representing Japan in the TOKYO1964 to those of the general public
＊: Report on 2017 Survey of Physical Fitness and Sports Proficiency (Japan Sports Agency)

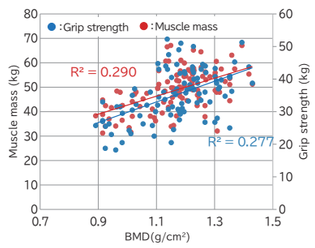

Figure 7: Correlation with BMD, muscle mass, and grip strength (2016)

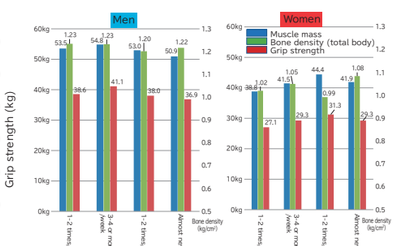

Figure 8: Relationship of exercise habits (frequency) with muscle mass, BMD(whole body), and grip strength (2012)

Refference

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Prevalence of Lifestyle-related Disease

Kazuyuki Kamahara[1)], Michiko Dohi[1)]

1) Japan Institute of Sports Sciences

●Overview of study results

380 athletes (314 men and 66 women) were the subjects of a follow-up survey of TOKYO1964 Olympians. The survey was conducted for the first time in 1968, and then every four years thereafter. Most recently, it was conducted for the 13th time in 2016. 106 athletes (average age of 75.5 ± 3.6) received medical examinations in the 13th survey, comprising 79 men (average age of 76.1 ± 3.4) and 27 women (average age of 74.0 ± 3.5).

We used the data obtained in the surveys through that point to examine what happens to the effects of having engaged in sports while young including daily vigorous exercise as one ages. With respect to the medical survey items, the items tested in the medical surveys such as specific blood test items at times differed during each study due to changes in how the diseases are conceptualized over time, but the main items that have been investigated are family history, past history (including surgeries), current medical history (disease under treatment, medicines for internal use, presence or absence of subjective symptoms), blood pressure, pulse, physical findings, blood testing, urinalysis, thoracic radiography, and resting electrocardiogram. The prevalence of so-called lifestyle-related diseases such as hypertension, dyslipidemia, and diabetes generally increases with age, and this prevalence increased with every successive survey even among the TOKYO1964 Olympians. We therefore compared the prevalence of lifestyle-related disease in the athletes who participated in the latest (13th) survey with that of the elderly in general. The results are given below.

●Hypertension

Individuals who had a systolic blood pressure of 140 mmHg and a diastolic blood pressure of 90 mmHg or more in the blood pressure measurement conducted at the 13th survey, or who had been diagnosed with hypertension and took medicine for it by the 13th survey, were defined as hypertensive. In the 13th survey, 41 men (51.9%) and 11 women (40.7%) had hypertension. In the results of the *2014 Japan National Health and Nutrition Survey*[1)] by the Ministry of Health, Labour and Welfare, the percentage of men aged 70 and over with hypertension was 72.1%, and that of women was 70.9%, suggesting that the results for both male and female TOKYO1964 Olympians were low (Fig. 1). In the 13th survey, 3 men and 2 women had comorbid hypertension and diabetes, and 6 men and 1 woman had comorbid hypertension and dyslipidemia. Of these, 2 of the men had comorbid hypertension, diabetes, and dyslipidemia.

●Obesity

Body Mass Index (BMI) was calculated based on body length and body weight measured during the 13th survey, with a BMI of 25 or greater defined as obese. Of the TOKYO1964 Olympians who had a BMI of 25 or greater in the 13th survey, 26 (32.9%) were men and 5 (18.5%) were women. However, the ratio among those age 70 or older in the same generation in the general population was 24.7% for both men and women (Ministry of Health, Labour and Welfare, *2014 Japan National Health and Nutrition Survey*[1)]), indicating that the rate of obesity among female TOKYO1964 Olympians was lower than the general population (Fig. 2).

●Dyslipidemia

The current diagnostic criterion for dyslipidemia is to meet one or more of LDL-C ≥ 140 mg/dl, HDL-C <40 mg/dl, and/or TG ≥ 150 mg/dl. However, only HDL-C and TG were measured in blood testing conducted during the 13th survey. In the results of the 2014 Japan National Health and Nutrition Survey1) conducted by the Ministry of Health, Labour and Welfare, those with HDL-C <40 mg/dl or those undergoing treatment were suspected of having dyslipidemia. Statistics were collected, with prevalence of 33.7% and 36.2% of men and women, respectively, in the general population of individuals age 70 or older. In the results of the 13th survey of the TOKYO1964 Olympians using the same criteria, 14 men (17.7%) and 6 women (22.2%) were suspected of having dyslipidemia, and the ratio of both male and female TOKYO1964 Olympians suspected of having dyslipidemia was low (Fig. 3).

●Diabetes

Individuals who had an HbA1c of 6.5% or greater during the blood testing conducted in the 13th survey or who had been diagnosed with diabetes and took medicine for it by the 13th survey, were defined as diabetic. The results indicated that 10 men (12.7%) and 5 women (18.5%) had diabetes during the 13th survey of TOKYO1964 Olympians. In the results of the *2014 Japan National Health and Nutrition Survey*[1)] by the Ministry of Health, Labour and Welfare, the percentage of men aged 70 and over "strongly suspected as having diabetes" was 22.3%, and that of women was 17.0%, suggesting that the results for male TOKYO1964 Olympians were low (Fig. 4).

●Hyperuricemia

Individuals who had a blood uric acid level of 7.0 mg/dl or greater during the blood testing conducted in the 13th survey or who had been diagnosed with hyperuricemia or gout and had taken medicine for their condition by the 13th survey were defined as hyperuricemic. In the 13th survey, 18 men (22.8%) and 1 woman (3.7%) had hyperuricemia (blood uric acid level of 7.0 mg/dl or greater). In the results of the *2014 Japan National Health and Nutrition Survey*[1)] by the Ministry of Health, Labour and Welfare, the percentage of men aged 70 and over with hyperuricemia was 13.6%, and that of women was 4.6%, indicating that the results for male TOKYO1964 Olympians were high (Fig. 5).

●summary

The incidence of so-called "lifestyle-related diseases" such as hypertension, dyslipidemia, and diabetes was lower in both male and female TOKYO1964 Olympians when compared to the elderly in general over the age of 70, while obesity (BMI of 25 or greater) was lower only in the female TOKYO1964 Olympians. Also, the rate of hyperuricemia in male TOKYO1964 Olympians was higher when compared to the general population. No relationship between the incidences of these diseases and current exercise habits was observed, nor was any between their incidences and the types of sports in which the athletes had engaged. No relationships between the incidences of the diseases and the sports in which the athletes engaged or current exercise habits could be clarified in this study because the population parameter for each sport was too small.

Reference

1) Ministry of Health, Labour and Welfare: Report on 2014 Japan National Health and Nutrition Survey https://www.mhlw.go.jp/bunya/kenkou/eiyou/h26-houkoku.html

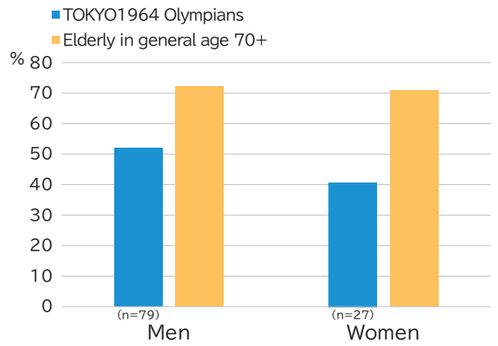


Figure 1: Comparison of prevalence of hypertension (during 13th survey)

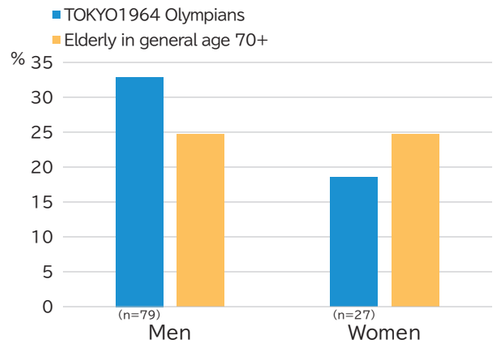


Figure 2: Comparison of BMI (during 13th survey)

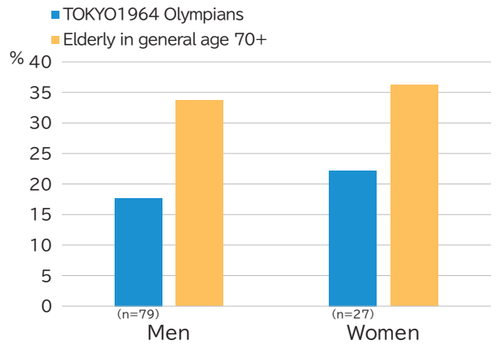


Figure 3: Comparison of prevalence of dyslipidemia (during 13th survey)

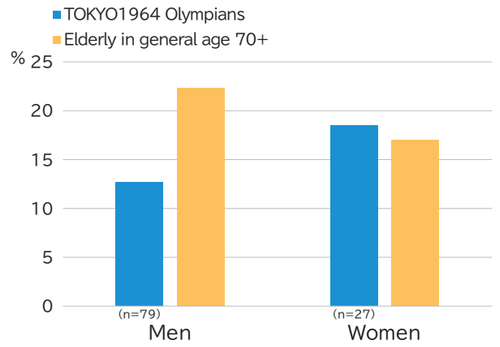


Figure 4: Comparison of prevalence of diabetes (during 13th survey)

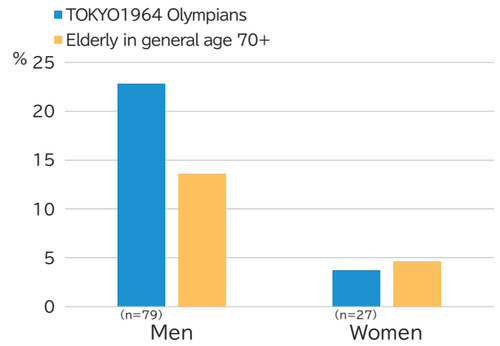


Figure 5: Comparison of prevalence of hyperuricemia (during 13th survey)

The Relationship Between the State of Engagement in Exercise/ Sports and Medical Evaluations: Dental Evaluations

Toshiaki Ueno[1)], Yukako Toyoshima[2)]

1) Tokyo Medical and Dental University; 2) Japan Institute of Sports Sciences

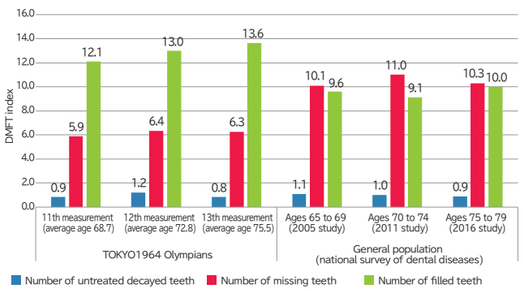
●Overview of study results

Tokyo Olympic Commemoration Physical Fitness Study is a major research project that has been conducted every four years since 1968 for more than five decades since the Tokyo Olympic Games were held in 1964. Dental examinations have been conducted since the 11th measurement in 2008 and, together with the dental examinations in the 12th and 13th measurements, examination data from a total of three measurements has been accumulated. The following findings were obtained as a result of analytically evaluating the data again on the occasion of this study.

- There is a high risk of caries (tooth decay) and many teeth have been treated.
- Although many subjects exhibited no periodontal disease findings, subjects tended to be polarized in this respect.
- Few of the subjects' teeth were missing, and they retained four to five more teeth than the elderly in general.
- Even in their 70s, they maintained a high level of masticatory functioning.

The above findings suggest that the dental and oral health conditions of the former first-class competitors were better maintained than those of the elderly in general. Considering the fact that they have maintained good exercise habits not only during their active careers but also after retirement, it may be the case that the carry-over effect of exercise is also manifest in the health of their teeth and oral cavities.

●The risk of caries is high, and many teeth have been treated



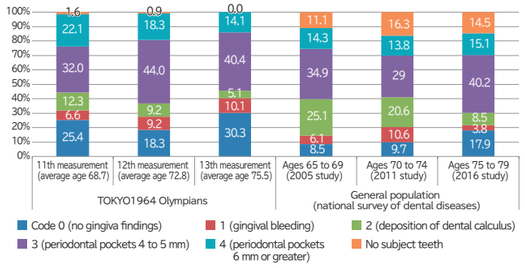
This graph compares the average number of decayed, missing, or filled teeth in the TOKYO1964 Olympians and the elderly in general in Japan. The Decayed, Missing, and Filled Teeth (DMF or DMFT) index is one of the epidemiological indexes that show the morbidity of caries that cannot be expected to heal naturally and their progression up to that point. It expresses the total number of untreated decayed teeth (D), missing teeth (M), and filled teeth (F).

The average numbers of untreated decayed teeth, missing teeth, and filled teeth of the TOKYO1964 Olympians who underwent dental examinations at the 11th measurement in 2008, the 12th measurement in 2012, and the 13th measurement in 2016 are plotted in the left half of the graph, and the data concerning the elderly in general obtained from the national survey of dental diseases conducted by Ministry of Health, Labour and Welfare in 2005, 2011, and 2016 are plotted in the right half of the graph. The number of Tokyo Olympians measured in the 11th, 12th, and 13th measurements were 123 (99 men and 24 women with an average age of 68.7), 109 (84 men and 25 women with an average age of 72.8), and 99 (75 men and 24 women with an average age of 75.5), respectively.

A characteristic finding of the former top athletes was the large number of their teeth that had been treated for caries. The former top athletes had an average of 2.5 more teeth than the general population between the 11th measurement and the 2005 national survey of dental diseases, 3.9 more between the 12th measurement and the 2011 study, and the 3.6 more between the 13th measurement and the 2016 study. It has been reported in Japan and abroad that the risk of caries in sports athletes is higher than that of the general population and their prevalence of caries is also high. It is presumed that many of the former first-class competitors also had caries in their teeth while actively competing and received treatment and fillings. As a result, it is probably reasonable to think that the number of treated teeth had increased.

Another matter of note was the small number of missing teeth. The tendency for there to be four or fewer missing teeth among the former athletes than in the elderly in general of the same generation remained consistent from the 11th measurement through the 12th and 13th. According to the 2016 national survey of dental diseases, an average of 4.6 teeth are lost in the early 60s, 6.7 in the late 60s, 8.6 in the early 70s, and 10.3 in the late 70s. This is the image of the elderly in general in Japan. However, the average number of missing teeth in the TOKYO1964 Olympians in later old age (average age of 75.5) was only 6.3. This means that their oral age was equivalent to their late 60s, which was more than 10 years younger than their actual age.

●Although many subjects exhibited no periodontal disease findings, the Olympians tended to be polarized in this respect



This graph compares the TOKYO1964 Olympians with the CPITN ratios of the elderly in general in Japan. The Community Periodontal Index of Treatment Needs (CPI or CPITN) is a periodontal examination method advocated by the WHO in 1982. It is an index for determining the condition of periodontal disease and the need for treatment in a community.

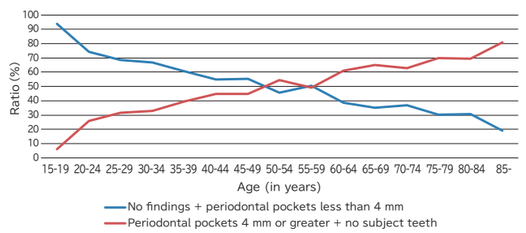
The ratio of individuals designated as Code 0 (no periodontal disease findings) at the time of the 13th measurement was 30.3%. The ratio of individuals designated as Code 0 in the 2016 national survey of dental diseases was 17.9%, so it seems that the TOKYO1964 Olympians were a population with few individuals afflicted with periodontal disease. However, if you add the ratios of individuals designated as Code 3 (shallow periodontal pockets) and Code 4 (deep periodontal pockets) the figure rises to 54.1%~62.3% - a majority. Because of this, it seems that there was a trend toward polarization. Even so, following the changes from the 11th measurement, the number of individuals designated as Code 4 gradually decreased to 22.1%, 18.3%, and 14.1%, and the number of individuals designated as Code 2 (deposition of dental calculus) also decreased by 7 points, so there was a trend toward improvement.

●The three keys to preventing periodontal disease are "maintenance of normal body weight," "good diet," and "active exercise habits."

In the same way as hypertension, diabetes, and the like, periodontal disease is also a lifestyle-related disease. Based on this approach, three keys to preventing periodontal disease are advocated: (1) maintenance of normal body weight (BMI: 18.5~24.9 m/kg^2), (2) good diet (Healthy Eating Index: 80+), and (3) active exercise habits (moderate-intensity exercise at least five times a week or high-intensity exercise at least 3 times a week). In particular, the benefits of exercise should be emphasized, as it has been reported in epidemiological studies conducted outside Japan that the prevalence of periodontal disease in a population with active exercise habits is significantly lower.

With respect to the state of engagement in exercise by the TOKYO1964 Olympians, of the 273 Olympians who cooperated with the survey at the time of the 13th measurement, 50 (18.3%) were exercising one or two days a week, and 56 (20.5%) were exercising three or four days a week without fail. Considering that this is a population that had maintained good exercise habits after retirement, not to mention during their youthful eras of active competition, this could probably be interpreted as another data point that supports the efficacy of maintaining exercise habits in the prevention of periodontal disease. This suggests, therefore, that many of the former first-class competitors have healthy periodontal tissue and are less prone to developing periodontal disease.

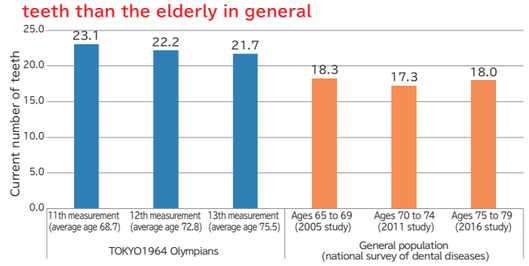
●In general, periodontal disease becomes serious from one's 50s onwards, necessitating regular checkups and preventive measures



Generally speaking, from what age does periodontal disease become serious? In order to clarify this point, a graph of the results calculated based on the 2016 data of national survey of dental diseases is provided. Usually, when the periodontal pocket is 4 mm or more, it becomes difficult to control plaque with self-care alone, so treatment is required. When the subjects were divided into two groups with one consisting of individuals designated as Codes 0, 1, and 2 (no findings + periodontal pockets of less than 4 mm) and the other consisting of individuals designated as Codes 3 and 4 as well as individuals with no subject teeth (periodontal pockets of 4 mm or greater + no subject teeth), two points of convergence in the subjects' 50s were confirmed. It can thus be said that periodontal disease becomes serious starting from one's 50s.

Periodontal disease is also called "silent disease" of the mouth. Subjective symptoms are unlikely to manifest, and it often progresses without its sufferers being aware. Therefore, it is important to work to prevent it by undergoing regular medical examinations while observing the three keys.

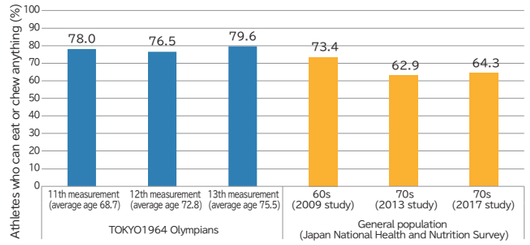
●The TOKYO1964 Olympians retained four or five more teeth than the elderly in general



This graph compares the numbers of teeth in the TOKYO1964 Olympians and the elderly in general in Japan. The average number of teeth in the data for the Tokyo Olympians from the 11th measurement through the 13th measurement in the left half of the graph is 22.3. Meanwhile, the average number of teeth for the elderly in general in the right half of the graph is 17.9, a difference of 4.4.

As mentioned above, the TOKYO1964 Olympians had lost a small number of teeth due to caries, and many had healthy periodontal tissue, so it seems that this is related to the study result indicating that they had four or five more teeth than the elderly in general. For reference, the number of human teeth is 28, with 14 in each of the upper and lower jaws, excluding third molars (dens serotinus, or "wisdom teeth").

●The Olympians maintained a high level of masticatory force even in their 70s



This graph compares masticatory force in the TOKYO1964 Olympians and the elderly in general in Japan. Data on the ratio of individuals in the populations who responded "I can eat and chew anything" is plotted in the graph, and about 80% of the Tokyo Olympians reported good mastication even in later old age (average age of 75.5), a difference of more than 15 points from the elderly in general of the same generation.

It is likely that the inevitable conclusion to draw from this is that many of the former top-level competitors maintain a high level of masticatory strength due to their retention of a large number of teeth and having healthy periodontal tissue to support them.

Physiological Response of the Athletic Heart – The Athletic Heart is a Reversible Change

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●Overview of study results

Electrocardiographic testing was conducted on 365 TOKYO1964 Olympians before the Games took place in order to investigate changes in the electrocardiograms of elite athletes undergoing high-intensity training. The revised results of this testing are shown in Table 1 (1). Left ventricular hypertrophy was observed in more than half of the athletes, and sinus bradycardia was observed in more than 40%. Each of the electrocardiogram findings was confirmed at a higher ratio in the male athletes than in the female athletes.

Table 2 shows the results of the follow-up survey conducted by Maruyama et al. that targeted 88 male athletes for whom electrocardiograms in 1964 and 1976 could be evaluated in order to assess the relationship between changes in the electrocardiograms and sporting activities (1).

Though most of the changes in the electrocardiograms that had been confirmed in 1964 had disappeared by the time of the measurements in 1976, findings such as left ventricular hypertrophy persisted in some of the athletes. In the findings, the ratio in which sinus bradycardia and left ventricular hypertrophy persisted was significantly higher in the athletes who continued to compete than in those that had retired.

Changes to electrocardiogram findings were examined for the 32 of these 88 athletes who continued to undergo electrocardiogram evaluations every 4 years for 12 years after retiring from competition. The number of years after retirement and changes in the ratios of electrocardiogram findings are shown in Table 1.

The ratio of electrocardiogram findings that had been noted while the athletes were active declined with the passage of time after their retirement from competition, but symptoms of incomplete right bundle branch block and left ventricular hypertrophy persisted in about 20% of the athletes even 12 years after retirement. Atrioventricular block and sinus bradycardia had disappeared in all the athletes 4 years after retirement.

The effects of high-intensity training on the heart were tested with both electrocardiography and chest radiography. The results of tracking of the cardiac shadow area that were calculated using the Moritz method (2) based on the same testing for 10 athletes conducted before retirement from active competition and 12 years after retirement are shown in Fig. 2 (1).

More than half the athletes presented with cardiac dilatation at the time they were active competitors, but it was observed that their dilated hearts had tended to shrink after about 4 to 8 years had passed since retiring from active competition. Ultimately, the hearts of most of the athletes shrank to a size within the normal range for Japanese people.

Elite athletes perform dynamic and static exercises depending on the sport(s) in which they compete. Although the frequency of occurrence of each finding by the type of sport was not been evaluated in this study, it was confirmed that sinus bradycardia and atrioventricular block, which are thought to be caused by high-intensity training, disappeared after the athletes had ceased to actively compete. However, left ventricular hypertrophy and cardiac dilatation noted in the electrocardiograms or x-ray images had persisted in some of the athletes even 12 years after retirement.

An example of a track and field athlete for whom it was possible to perform follow-up examinations for about 50 years in order to examine the long-term progression in athletes that had presented with this sort of athletic heart is given below. The findings were compared while presenting the electrocardiogram and chest radiography examinations in 1968 and 2016.

The subject continued to compete actively even when the measurements were taken in 1968 and remained physically active until the time of the 2016 measurements. The electrocardiograms for 1968 and 2016 are shown in Fig. 3. In the findings of the 1968 measurements, the patient presented with incomplete right bundle branch block and left ventricular hypertrophy. Those findings were not observed in 2016, but left axis deviation was observed in the findings. A chest x-ray photograph taken at the same time as an electrocardiogram is shown in Fig. 4. The respective ratios of the lateral diameter of the cardiac shadow to the lateral diameter of the lung field (cardiothoracic ratio) in these were 41% and 42%, with almost no difference observed, however the estimated area of the cardiac shadow was clearly reduced in 2016 compared to 1968. It was also observed in the 2016 x-ray image that the position (tilt) of the heart in the thorax was more lateral compared with the 1968 examinations, and that there was meandering of the aorta. The left axis deviation in the electrocardiogram and the meandering of the aorta in the x-ray image were thought to have been attributable to the hypertension noted in the patient.

While the results of this study suggest that the effects of high-intensity training cause elite athletes to undergo electrophysiological and morphological changes, most of these are reversible changes, and such findings are normalized if the athletes stop actively competing.

It has been reported that the lifespans of elite athletes are generally longer than lifespans overall (3). However, there are still many unclear points with regards to the mechanism behind this longevity and the long-term effects on athletes for whom the electrocardiogram findings persist long-term, so further research in the future is needed.

Table 1. ECG findings for TOKYO1964 Olympians

	Men (301)	Women (64)	Overall (365)
Sinus bradycardia	135 (44.9%)	20 (31.3%)	155 (42.5%)
Left ventricular hypertrophy	192 (63.8%)	13 (20.3%)	205 (56.2%)
Incomplete right bundle branch block	15 (5.0%)	1 (1.6%)	16 (4.4%)
First or second degree atrioventricular block	3 (0.1%)	0	3 (0.1%)

Table 2. Evaluations of electrocardiograms of male athletes (88) in 1964 and 1976

	1964(88)	1976	
		Active (14)	Post-retirement (74)
Sinus bradycardia	45 (51.1%)	2 (14.3%)	1 (1.4%)
Left ventricular hypertrophy	66 (75.0%)	7 (50.0%)	16 (21.6%)
Incomplete right bundle branch block	5 (5.7%)	2 (14.3%)	2 (2.7%)
First or second degree atrioventricular block	2 (2.2%)	0	0

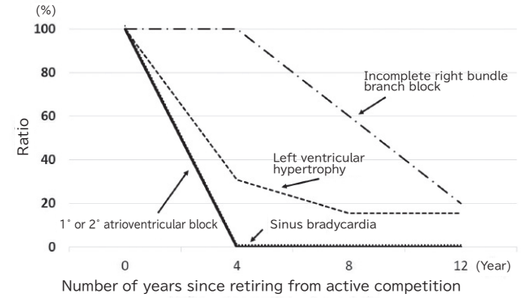

Figure 1. Number of years since retirement from competition and ratio of electrocardiogram findings

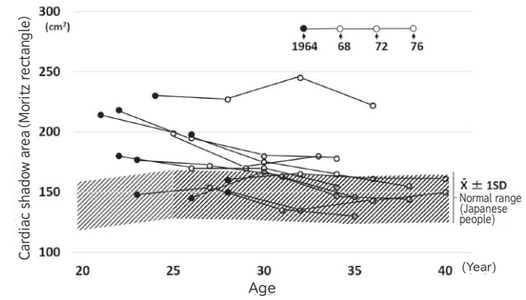

Figure 2. Relationship between cardiac shadow area derived using Moritz method and number of years since retirement

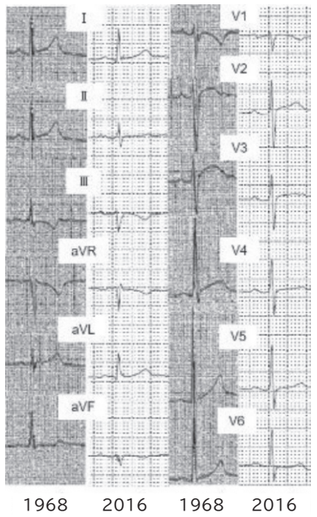

Figure 3. Electrocardiogram

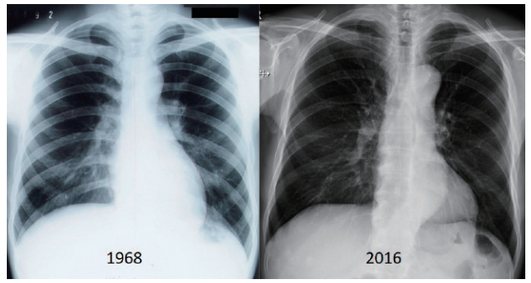

Figure 4. Chest x-ray photograph

(1) Murayama M. et al., Cardiovascular Future of Athletes. J Physical Fitness Japan 1980; 29: 117-123.
(2) Moritz F. Ueber die Norm der Groesse and Form des Herzens beim Mann. Deut. Arch, klin. Med. 1931; 171: 431-476.
(3) Lemez S. et al., “Do Elite Athletes Live Longer? A Systematic Review of Mortality and Longevity in Elite Athletes.” Sports Med Open 2015; 1:16.

New findings with a focus on frailty from a comparison between the TOKYO1964 Olympians and local elderly people in general: the TOKYO1964 Olympians representing Japan have high muscle mass and strength even in old age, but tend to have musculoskeletal pain and reduced walking speed

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1) University of Tokyo, Institute of Gerontology
2) University of Tokyo, Institute for Future Initiatives

●Are the physical abilities of the TOKYO1964 Olympians top-notch even in old age?

Many of the TOKYO1964 Olympians held are now elderly. They are top-notch competitors, and heroes in our nation's long history of sports. Although there are differences between the sports in which they competed, their musculature, muscle strength, and physical abilities that were maximized by their exercise habits in the prime of their life would likely have far surpassed those of the general population. So, have the top athletes who were exceptional enough to be chosen as Olympic athletes been able to maintain their superior physical abilities compared to the general population even in old age? We obtained surprising results when we attempted to answer this question by comparing muscle mass, maximum muscle strength, and physical functioning using the data accumulated over many years from the TOKYO1964 Olympians and the data from local elderly people in general. What follows is a report on these results.

●What sort of data were compared?

We used the data from the 101 participants (average age 75.0 ± 4.4 years, 26% of whom were women) in the Tokyo Olympic Commemoration Physical Fitness Study, and who also took part in the 13th measurements survey conducted in 2016 from whom all data concerning muscle mass, etc. was obtained, as well as data from 1,529 elderly people (average age 74.1 ± 5.5 years, 49% of whom were women) living in Kashiwa City, Chiba Prefecture, in order to compare lifestyle habits, nutritional status, physical capabilities, musculoskeletal pain, clinical histories, etc. In addition, considering that differences in sports in which subjects had competed and exercise habits after retirement would have a significant effect on results, we also investigated these. Specifically, the sports in which the subjects of this study had engaged were classified into three types of exercise intensity – static exercise intensity, dynamic exercise intensity, and cardiopulmonary exercise intensity, with each of these further divided into low, medium, and high intensity – per the 8th Task Force classifications in the Olympic sports categories of the American College of Cardiology (Fig. 1). In addition, the intensity of physical contact during sports competition was evaluated based on the definitions of the American Academy of Pediatrics, and the Olympic sports events were evaluated in three groups: no physical contact, limited physical contact, and full physical contact (Fig. 1). The post-TOKYO1964 exercise habits of the subjects were evaluated for the presence or absence of exercise habits of at least 1 - 2 times a week before the age of 50, using data from a self-administered questionnaire survey conducted every four years.

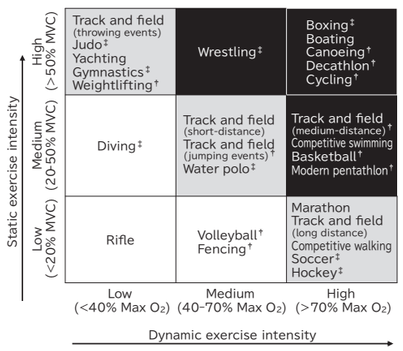

Figure 1: Olympic sport classification (exercise intensity and absence/presence of physical contact)
MVC, maximal voluntary contraction (Maximum voluntary muscle strength)
Cardiopulmonary exercise intensity is classified into three levels: low (white), medium (gray), and high (black).
†, ‡: Classification by absence/presence of physical contact († indicates limited physical contact; ‡ indicates occurrence of physical contact)

●Are there any differences in the clinical histories and lifestyle habits of the TOKYO1964 Olympians up to old age?

When we compared clinical histories through the present of the TOKYO1964 Olympians and the elderly in general, there were no statistically significant differences in the numbers of those who had a history of hypertension, diabetes, heart disease, and stroke, though these tended to be slightly less common in the TOKYO1964 Olympians. On the other hand, we found that the number of people who are prone to depression is rather high among the female TOKYO1964 Olympians. Regarding lifestyle habits, while there were no differences in exercise habits in old age, differences in dietary habits and drinking/smoking habits were observed. Specifically, former Olympic athletes were more likely to eat meat, seafood, eggs, vegetables, and fruits at least once every two days. Well-balanced dietary habits are important even in old age, and frequent consumption of the protein that comprises the building blocks of the body is especially recommended. The former Olympic athletes were superior in this respect, and they may have put to use the body-building know-how cultivated during their time as athletes to consume a healthy diet in old age. Also, in terms of smoking habits, there were fewer smokers among the TOKYO1964 Olympians. Alcohol intake was more frequent among the TOKYO1964 Olympians surveyed, especially among women.

●TOKYO1964 Olympians have high muscle mass and maximum muscle strength even in old age

Comparing the TOKYO1964 Olympians with the elderly in general, although there were no differences in BMI (body mass index), we found that the TOKYO1964 Olympians had higher skeletal muscle mass in their limbs and maximum muscle strength (grip strength). In particular, TOKYO1964 Olympians maintained extremely high amounts of skeletal muscle mass in their limbs compared to elderly women in general (Figs. 2 and 3). This is partly due to innate differences in their bodies, but it seems possible that insufficient exercise habits and low muscle mass in the younger generations of women in general have resulted in reduced skeletal muscle mass in their limbs in old age more than expected. Incidentally, the muscle weakness that is often observed in old age is called "sarcopenia." Sarcopenia is defined as "progressive and systemic skeletal muscle disease resulting in an increased risk of health problems such as falls, fractures, physical dysfunction, and death," and is diagnosed as a state in which a decline in skeletal muscle mass in the limbs is comorbid with decline in maximum muscle strength and body functioning. In fact, we found in our analysis results that few TOKYO1964 Olympians are in a sarcopenic state because of their high skeletal muscle mass in their limbs and maximum muscle strength. These conditions tended to be especially pronounced in athletes who had continued their exercise habits even after the age of 50, and in athletes in types of sports that have high exercise intensity. On the other hand, male athletes in sports with low exercise intensity lost their statistically significant difference from the elderly in general. From this, it can be said that in order to prevent sarcopenia in old age, it is necessary to engage in at least moderately intense exercise and important to continue the habit of exercising.

●TOKYO1964 Olympians are prone to having musculoskeletal pain in old age, and at times their balance ability and walking speed are rather low

We found that muscle mass and maximum muscle strength were higher in TOKYO1964 Olympians when compared with the elderly in general. However, we also found a reversal phenomenon of TOKYO1964 Olympians having a lower balance ability and walking ability than the elderly in general. Specifically, we found that TOKYO1964 Olympians were able to stand on one leg with their eyes open for a shorter duration and walked at a slower speed (Fig. 4). Additionally, when asked about musculoskeletal pain in the questionnaire, more TOKYO1964 Olympians reported having pain than the elderly in general, and the intensity of their pain was worse (Fig. 5). This tendency was more pronounced in athletes who quit exercising before the age of 50 and/or athletes who engaged in sports with high exercise intensity and physical contact. Although it cannot be said with certainty that these are all attributable to sports injuries caused by excessive training, etc., it seems possible that they could cause deterioration of physical functioning and chronic musculoskeletal pain in old age. Also, it is known that the proportion of people with chronic musculoskeletal pain generally increases with age, and musculoskeletal pain in old age is also considered to be a risk factor for decreased levels of activity of daily living and depressive tendencies. Therefore, although it is important to improve physical functioning starting from youth through old age as stated above, it seems possible that prevention and countermeasures for wounds and sports injuries will have a great impact on allowing athletes to live long and full lives.

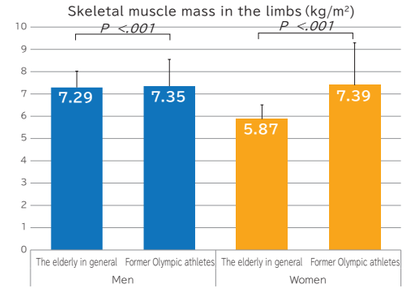

Figure 2: Comparison of average (standard deviation) skeletal muscle mass (kg/m2) in the limbs of the TOKYO1964 Olympians and the elderly in general

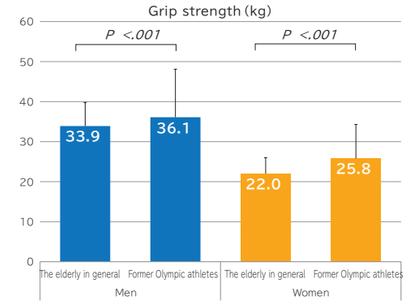

Figure 3: Comparison of average (standard deviation) normal walking speed (m/second) in the TOKYO1964 Olympians and the elderly in general

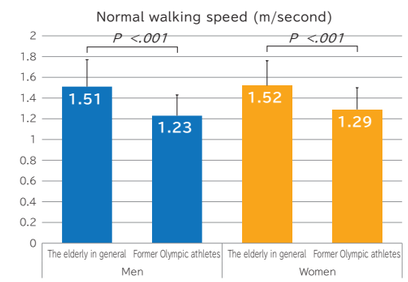

Figure 4: Comparison of average (standard deviation) normal walking speed (m/second) in the TOKYO1964 Olympians and the elderly in general

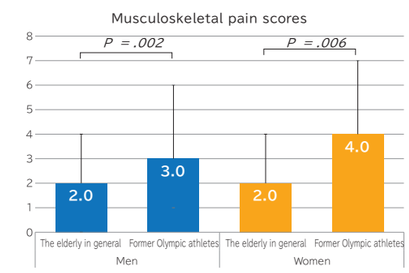

Figure 5: Comparison of median (interquartile range) musculoskeletal pain scores in the TOKYO1964 Olympians and the elderly in general
*The higher the pain score, the more intense the musculoskeletal pain

●Summary

We attempted to compare TOKYO1964 Olympians with local elderly people in general residing in Kashiwa City, Chiba Prefecture. Based on the results we were able to confirm that TOKYO1964 Olympians had superior skeletal muscle mass in their limbs and maximum muscle strength, as well as the importance of continuing to exercise after retirement from competition. It was apparent that establishing a foundation of healthy and active lifestyle habits starting from adolescence favorably influenced lifestyle habits in old age, and that these in combination with muscle mass and muscle strength that were increased earlier in life were also carried over into old age. It also became clear that many of the TOKYO1964 Olympians suffer from musculoskeletal pain, and lowered physical functioning. The TOKYO1964 will be held again in 2021, 57 years after 1964, and in order to utilize what was learned in the lives of the TOKYO1964 Olympians, it will be necessary to promote continued exercise from adolescence to prevent sarcopenia in old age, and especially to conduct further educational interventions and environmental improvements to foster prevention of injuries, etc. for competitors in sports. It is expected that a thesis summarizing the results of this study was published in an international academic journal (*Journal of Cachexia, Sarcopenia, and Muscle*).

Do Athletes Who Compete in the Olympic Games Live a Long Time? ～Vital prognoses of the TOKYO1964 Olympians～

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2) Department of Social and Environmental Medicine, Osaka University Graduate School of Medicine

●Overview of study results

We used survival/mortality information and physical fitness measurement data as of December 31, 2017 for 355 athletes (295 men and 60 women) who competed in the TOKYO1964 Olympians to perform a survival time analysis and multivariate analysis with mortality as an outcome. Using information publicly available on the Internet, etc., we analyzed a total of 342 athletes (283 men and 59 women) who remained after eliminating those athletes for whom outcomes were unknown, in the Tokyo Olympic Commemoration Physical Fitness Study. A total of 15974.8 person-years were observed, with an average observation period of about 47 years.

We analyzed their vital prognoses compared to the general population based on our calculation of a Standardized Mortality Ratio (hereinafter, "SMR") using mortality rates by gender and age class every 5 years based on the Japanese Vital Statistics (1950～2015). Their overall SMR was estimated to be 0.64 (95% confidence interval: 0.50, 0.81), indicating that their mortality rate was about 40% lower than that of the general population; i.e. the TOKYO1964 Olympians lived longer.

Next, we performed a multivariate analysis (using the Cox Proportional Hazards Model) of the factors related to mortality rates using the physical fitness measurement data from the baseline and first-time (1964 and 1968) measurements with exercise intensity categories of the sports in which the athletes competed, the total number of times they competed in the Olympic Games, lifestyle habits (smoking history, body mass index categories: BMI <23, 23-25, 25 <BMI), etc. as covariates. The results of a comparative investigation within the cohort indicated a hazard ratio of 3.18 (95% CI: 1.34, 7.55) in the group with a BMI of 25 kg/m^2 or more when the group with a BMI of less than 23 kg/m^2 (=1) was used as the standard; thus, it was demonstrated that their risk was about three times higher – a significant difference. Also, a tendency was observed for the mortality rate to increase the more times athletes participated in the Olympic Games. Although no statistically significant difference was shown, it appears that this does not conflict with the results (Takeuchi et al., 2019) of our earlier study that tracked successive generations of postwar Olympic athletes. Additionally, it was observed in the results of our investigation of the relationship between mortality rates and exercise habits after retirement that compared to the group who responded that they exercised "never" or "almost never," the risk of death was reduced (HR: 0.78 to 0.83) by about 20% among those who reported exercising habits of "once or twice a month (i.e. frequency)" to "competitive level," but no statistical significance was shown.

The majority of the health surveys for general local residents are conducted for the purpose of investigating the effects of lifestyle habits on people aged 40 and older. In the case of TOKYO1964 Olympians, however, it is necessary to consider that the average age is around 23 years old and the targets constitute an extremely young cohort. It cannot be denied that factors that increase the risk of death may be related to factors other than obesity, etc.

In general, exercise habits are effective in preventing such lifestyle-related diseases as cardiovascular disease, hypertension, and cancer, so apparently few would argue against the proposition that athletes live longer lives. However, there has been hardly any investigation of the effect on disease risk and mortality in populations subjected to long-term excessive training, high-intensity exercise, significant dietary restrictions, use of anabolic steroids, etc. in the manner of Olympic athletes. We sincerely hope that a system able to track all Olympic athletes for their entire lives and a mechanism capable of managing and operating a valuable database will be established in the future.

●Breakdown of subjects analyzed (Tables 1-1 and 1-2):

Of the 355 TOKYO1964 Olympians (295 men and 60 women), 342 remained after excluding those whose survival information or dates of decease were not known. Of these 342, it was confirmed that 70 (64 men and 6 women) had died. Table 1-1 gives the number of athletes who died and their mortality ratios by the sports in which they competed. At the time of the analysis, the highest number of deaths (12) was among athletes who had competed in track and field events, but judo (50%) had the highest ratio of deaths among the TOKYO1964 Olympians. Table 1-2 gives the data for the baseline physical fitness measurements in 1964.

●Standardized Mortality Ratio (SMR): Results of Standardized Mortality Ratio-based general population comparison:

We used the mortality rate by sex and age group every five years in the Japanese Vital Statistics (1950 ～ 2015) to calculate SMR by observation period and by the number of elapsed years since competing in the TOKYO1964 (Table 2). Having taken into consideration differences attributable to the historical background, we conducted an analysis by dividing the observation period into three segments so that the number of observed deaths was roughly equalized and dividing the elapsed years into four categories. In the SMR by observation period, there was a significant decline in mortality rates during the most recent period (2008 to 2017). In the SMR by elapsed years, a significant decline in the mortality rate was shown for the group for whom more than 30 years had passed.

●Investigation of mortality-related factors using the Cox Proportional Hazards Model (Table 3)

The results of a multivariate analysis with death as an outcome are given in Table 3. A tendency for the risk of death to increase was observed for the group that had participated in the Olympic Games multiple times compared to the athletes who had done so only once, but no statistical significance was shown. In the same way, in the hazard ratios by exercise intensity by event name, a tendency for the risk of death to increase was observed for the moderate-intensity and high-intensity events, but no statistical significance was shown. With respect to BMI (body mass index), it was shown that the risk increased by about three times only in the group of 25 kg/m^2 or more – a statistically significant increase.

●Exercise habits and risk of death at baseline (baseline physical fitness measurements) (Fig. 1, Table 4)

A Kaplan-Meier curve stratified by exercise habits (reported in a questionnaire) as of 1968 is given in Fig. 1. Exercise habits were classified into three groups: "almost never (or never)," "about once or twice a month or 1 to 4 times a week," and "competitive level." No significant difference was shown in a logrank test (p = 0.99). Adjusted hazard ratios derived using the Cox proportional hazards model are given in Table 1. No statistical significance was shown as much data concerning exercise habits was missing, but a reduction in risk of death by about 20% was observed in the groups whose exercise habits were "about once or twice a month or 1 to 4 times a week" or "competitive level" compared to the "almost never (or never)" group (Fig. 1, Table 1 on page 15 of the 2nd report).

Rreference

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Table 1-1 (Breakdown of survival information by event)

Event name	Number of participants	Number of individuals confirmed deceased (%)
Athletics	67	12 (17.9)
Swimming	58	9 (15.5)
Volleyball	24	7 (29.2)
Rowing	23	4 (17.4)
Football	19	7 (36.8)
Hockey	16	3 (18.8)
Wrestling	15	4 (26.7)
Cycling	15	2 (13.3)
Fencing	15	1 (6.7)
Artistic Gymnastics	14	1 (7.1)
Sailing	12	2 (16.7)
Canoe	12	2 (16.7)
Basketball	11	3 (27.3)
Boxing	9	3 (33.3)
Equestrian	9	3 (33.3)
Rifle shooting	8	2 (25)
Weightlifting	7	3 (42.9)
Judo	4	2 (50)
Clay shooting	2	0 (0)
Modern pentathlon	2	0 (0)
Total	342	70

Table 1-2: (Distribution by lifestyle risk factors at time of baseline physical fitness measurements)

	Men	Women	Unknown, n
	n; 283	n; 59	(%)
Age (mean ± Sd)[in years]	23.8 ± 3.8	22.3 ± 4.7	3 (0.9)
Obesity coefficient BMI, n (%)			
<19 [kg/m^2]	11 (3.9)	5 (8.6)	4 (1.2)
19-<21 [kg/m^2]	55 (19.6)	16 (27.6)	
21-<23 [kg/m^2]	107 (38.2)	17 (29.3)	
23-<25 [kg/m^2]	70 (25)	18 (31)	
≥25 [kg/m^2]	37 (13.2)	2 (3.4)	
Smoking, n (%)			
Nonsmoker	104 (52)	44 (92)	95 (27.8)
Occasional smoker	30 (15)	1 (2)	
Daily smoker	65 (33)	3 (6)	
Grip strength segment, n (interquartile range [kg])			
Q1; 1st quartile	73 (33.0-48.5[kg])	15 (27.3-32.5[kg])	15 (4.4)
Q2; 2nd quartile	66 (48.5-53.0[kg])	13 (32.5-35.1[kg])	
Q3; 3rd quartile	66 (53.0-58.3[kg])	16 (35.1-38.0[kg])	
Q4; 4th quartile	66 (58.3-80.5[kg])	12 (38.0-49.5[kg])	
Drinking, n (%)			
Nondrinker	64 (32)	35 (73)	93 (27.2)
Social drinker	105 (52)	12 (25)	
Daily drinker	32 (16)	1 (2)	

Table 2 (SMR by observation period/elapsed years)

	Total number of person-years observed	Number of deaths	Number of expected deaths	SMR (95% CI)
Observation period				
1964-1997	10696.74	24	32.01	0.75 (0.49-1.10)
1998-2007	3049.08	23	32.67	0.70 (0.46-1.04)
2008-2017	2704.75	23	58.82	0.39 (0.25-0.58)
Elapsed years (years)				
0 to less than 10	3395.22	4	5.49	0.73 (0.23-1.76)
10 to less than 20	3341.92	6	7.66	0.78 (0.32-1.63)
20 to less than 30	3272.19	10	15.40	0.65 (0.33-1.16)
30 or more	6441.23	50	94.96	0.53 (0.40-0.69)

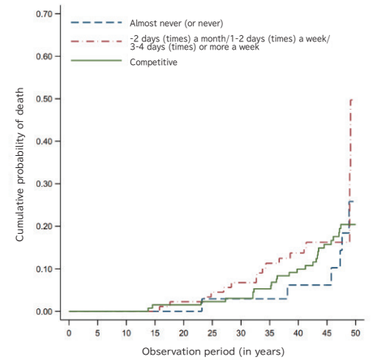

Figure 1. Survival curves (Kaplan-Meier plots) by the exercise habit at the first measurement in 1968.

Table 3 (Relationship between various exposure factors and risk of death)

	Number of applicable individuals (%)	Total number of person-years observed	Number of deaths	Adjusted hazard ratio (HR)		
				HR	95% CI	P for trend
Total number of times participants competed (times)						
1	228 (66.67%)	11174.03	43	Ref		0.727
2	86 (25.15%)	4105.45	20	1.18	0.55-2.55	
3 or more	28 (8.19%)	1179.98	7	1.14	0.32-4.06	
Exercise intensity (dynamic)						
Low	76 (22.22%)	3591.58	16	Ref		0.352
Medium	73 (21.35%)	3548.05	16	1.69	0.67-4.25	
High	173 (50.58%)	8353.44	35	1.61	0.63-4.09	
Unknown	20 (5.85%)	966.39	3			
Smoking history						
No	149 (43.57%)	7339.65	25	Ref		0.786
Yes	99 (28.95%)	4834.42	18	1.1	0.57-2.12	
Unknown	94 (27.49%)	4285.39	27			
BMI						
Less than 23	211 (61.70%)	10147.77	39	Ref		0.017
23 or more but less than 25	88 (25.73%)	4399.8	13	1.28	0.6-2.75	
25 or more	39 (11.40%)	1743.15	16	3.18	1.34-7.55	
Unknown	4 (1.17%)	168.74	2			

Table 4 (Relationship between exercise habits after competing in the TOKYO1964 and risk of death)

	Total number of person-years observed	Number of individuals who died	Adjusted hazard ratio		
			Hazard ratio	95% confidence interval	P-value
Exercise Habits					
Almost never (or never)	1549.0	6	Ref		0.802
About once or twice a month/about 1-4 times a week	3941.8	16	0.78	0.28-2.14	
Competitive	6008.6	25	0.83	0.31-2.20	
Missing	3676.8	23			

Effects of Post-Retirement Changes in Physical Fitness and Weight on the Health of the TOKYO1964 Olympians

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●Overview of study results

- In order to clarify the relationship between cardiorespiratory fitness in the TOKYO1964 Olympians at the time of their participation and the onset of hypertension after their retirement from active competition, we investigated the relationship between cardiorespiratory fitness at the time of their participation in the Olympic Games and their incidence of hypertension during the follow-up period in which they were tracked until 2016.
- Based on the results of the investigation, it was confirmed that, even for top athletes, low cardiorespiratory fitness is a risk factor for developing hypertension similar to the results reported in studies of the general population.
- We also compared their weights at the time of their participation in the TOKYO1964 with their weights 8 or 12 years later, and investigated the relationship between the incidence of hypertension and diabetes relative to changes in body weight.
- Based on the results of the survey, it was confirmed that athletes who gained more weight after participating in the Olympic Games tended to have a higher incidence of hypertension and diabetes, and even top athletes who gained weight after retiring from active competition were more likely to develop hypertension and diabetes than those who maintained their weight.

●Relationship between the physical fitness of the TOKYO1964 Olympians and their incidence of hypertension after retiring from active competition

It is known that the aspect of physical fitness that has the strongest correlation with health is cardiorespiratory fitness. Even for athletes who participated in the Olympic Games, it seems that there is variation in cardiorespiratory fitness that is dependent on the type of sport in which they engaged and the training levels of the individual athletes. In this study we investigated the relationship between the cardiorespiratory fitness of athletes at the time of their participation in the TOKYO1964 and their incidence of hypertension during the follow-up period in which they were tracked until 2016, in order to clarify the relationship between cardiorespiratory fitness and hypertension in top athletes.

(1) Methods

The subjects analyzed in this study were 156 athletes whose cardiorespiratory fitness was measured in the first Commemorative Tokyo Olympic Commemoration Physical Fitness Study that were held in 1964, and who participated at least once in the measurements held in 2005, 2008, 2012, and 2016. Next, we classified these athletes into three groups based on the results of their cardiorespiratory fitness measurements: “relatively low fitness,” “average fitness,” and “relatively high fitness.” We then checked the states of hypertension onset in each group during the follow-up period.

(2) Results

We calculated the relative risk of the “average fitness” and the “relatively high fitness,” groups using the “relatively low fitness” group as the baseline. The results of these calculations indicated that the “average fitness” group had a 25% lower relative risk compared to the “relatively low fitness” group. In addition, the relative risk value exhibited by the “relatively high fitness” group was 41% lower compared to the “relatively low fitness” group, and the higher the fitness, the lower the risk of developing hypertension (Fig. 1). Based on these results, it was confirmed that low fitness is a risk factor for developing hypertension even for top athletes similar to the results reported in the study of the general population.

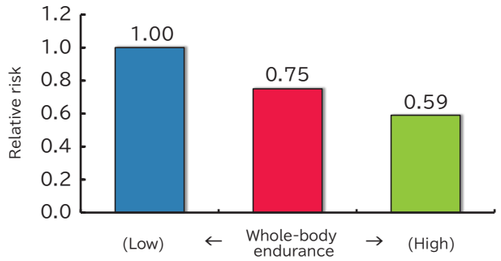


Figure 1: Relative risk of developing hypertension observed in different levels of fitness

●Relationship between changes in the weights of the TOKYO1964 Olympians and the incidence of hypertension and diabetes after retiring from active competition

Obesity is associated with a myriad of health problems, making it a major world health issue. Even for top-level athletes who participated in the Olympic Games, changes in weight due to changes in the environment, such as retirement from active competition after participating in the Olympic Games and a decrease in the amount of training, may affect their health. Therefore, in this study we checked how much the weights of the athletes changed 8 or 12 years after their participation in the TOKYO1964 and investigated the relationship between the amounts of these changes in weight and the development of hypertension and diabetes in order to clarify how weight changes after participating in the Olympic Games affected the development of hypertension and diabetes.

(1) Methods

The subjects analyzed in this study were 109 athletes whose physical fitness was measured in the first Tokyo Olympic Commemoration Physical Fitness Study, participated in the measurements held in 2005, 2008, 2012, and 2016 at least once, and underwent blood pressure measurement and blood testing. We calculated the differences in the weights of the athletes 8 years (1972) or 12 years (1976) after their participation in the TOKYO1964 using their weights measured in the first Tokyo Olympic Commemoration Physical Fitness Study conducted in commemoration of the TOKYO1964 as the baseline and classified the athletes into three groups: “lost weight,” “marginal weight gain,” and “substantial weight gain” groups. Then, we checked the states of hypertension and diabetes onset in each group based on the results of blood pressure measurements and blood testing conducted during the follow-up period.

(2) Results

We calculated the relative risk of developing hypertension and diabetes in the “marginal weight gain” and the “substantial weight gain” groups using the “lost weight” group as a baseline. The results of these calculations indicated that the “marginal weight gain” group had a relative risk of developing hypertension that was 1.57 times higher compared with the “lost weight” group. Also, the “marginal weight gain” group had a relative risk of developing diabetes that was 3.04 times greater than that of the “lost weight” group. Additionally, the “substantial weight gain” group had relative risks of developing hypertension and diabetes that were 2.93 and 4.28 times greater, respectively, compared to the “lost weight” group. The results indicated that the more weight is gained, the higher the risk of developing hypertension and diabetes (Figs. 2 and 3). Based on these results, it was confirmed that even for top athletes, gaining weight after retirement from active competition was a risk factor in developing hypertension and diabetes similar to the results that were reported in studies of the general population.

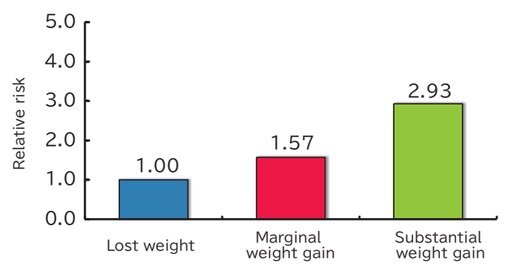


Figure 2: Relative risk of developing hypertension observed in different amounts of changes in weight

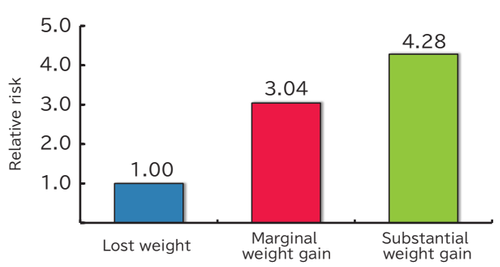


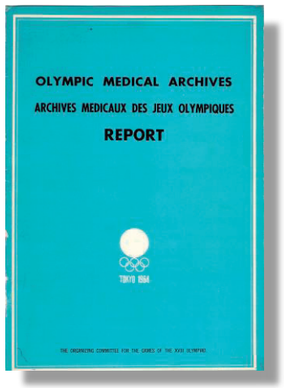
Figure 3: Relative risk of developing diabetes observed in different amounts of changes in weight

一流競技者の健康・体力追跡調査
―東京オリンピック記念体力測定― 報告書

1964年に東京で開催された第18回オリンピック競技大会に出場した日本代表選手の生涯にわたる健康と体力を調査すべく、4年に1度、オリンピック競技大会が開催される年にアンケート調査と体力測定を行う「東京オリンピック記念体力測定」を実施してきました。この「東京オリンピック記念体力測定」では、1968年から2016年の間に計13回に渡り、生活習慣、運動習慣、健康状態および病歴などが調査されてきました。

また、2019年および2020年には、「東京オリンピック記念体力測定」の「総括」として、50年以上にわたる膨大な調査結果を縦断・総合的に分析するとともに、循環器学や疫学、老年医学等の視点からも分析を行いました。

本冊子や研究報告書は日本スポーツ協会公式ホームページにて閲覧することができます。



JSPO 五輪測定 検索

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―流競技者の健康・体力追跡調査 –東京オリンピック記念体力測定– の総括

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Follow up study on the TOKYO1964 Olympians

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