中・高年期における体力低下傾向の検討

——30歳から59歳を対象として——

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A study on the deterioration trend of physical fitness in the middle adulthood; 30 through 59 years old

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これまで，体力の発育発達研究の多くは，いわゆる発育期を対象としている。また，ある数学関数を発育現量値曲線，速度曲線に当てはめ，当てはめられた曲線の特性を検討する事から，発育特性を見出そうとする研究も多くはないが，1930年以来なされている。しかし，壮年期における体力の低下傾向の検討に数学関数を当てはめてその特性を検討した研究はない。そこで，本研究では30歳から59歳までの30年間における体力の低下傾向に年齢の高次多項式を当てはめ，その多項式の曲線，一次，二次微分曲線を考察する事から，体重，敏捷性，瞬発力，筋力，体力一般の５体力要素の壮年期における低下傾向の特性を検討した。

用いられた資料は著者によって筑波大学学術情報処理センターにデータベースとして構築されてある文部省壮年体力テスト成績（1976～1987）から1984年から1987年までの４年間のデータをプールしたものである。４年間のデータをプールしたのは用いるデータの客観性を高め，結果の一般化の可能性を高めるためである。

女性の体重を除いて，すべての体力要素は一貫して低下傾向を示すが，その傾向は低下速度の加速，減速を繰り返しながら低下が続くと考えられ，直線的に低下が進行するものではないと推測された。特に，男性では40歳代，女性では30～40歳代前半にかけて，ほとんどすべての体力要素において，その低下傾向が加速されると考えられた。

Keywords：　Middle adulthood, Physical fitness, Deterioration trend, Polynomial, Derivative curve

1．Introduction

Several studies[3),5),6),7),8),9),12)], but not so many, have attempted to analyze the characteristics of growth and development of physical fitness through fitting a certain mathematical function of t; age or the transformed value of actual age, to its distance and/or velocity curves. In these studies a certain type of exponential function, logistic function, and polynomial have been utilized. However, any study was never attempted to analyze the characteristics of deterioration processes of physical fitness for the elderly people. It has been recognized widely that most of physical fitness elements deteriorate after 30 years old.[1),10),11)] And their lowering trends are not linear.[14)] In other words, they may lower slowly in some term and quickly in another term. Thus, it can be assumed reasonably that the distance curve may be convex upwards in some term and cancave upwards in other term or linear over all the term.

Then, in this study, the characteristics of

deterioration trend of physical fitness were investigated by fitting some polynomials of appropriate order to their distance curves over 30 years, from 30 through 59 years of age. If a polynomial of appropriate order can be fitted the distance curve, the first and second derivatives may give its velocity and acceleration. Then, some characteristics concerning deterioration trend may be deduced by investgating its velocity and acceleration.

2 . Method

Actually eight physical fitness measures were selected; stature, body weight, agility(side step), power(vertical jump), muscular strength(grip strength), agility(zigzag run), endurance(1500m fast walk for male and 1000m for female) and physical fitness score that is sum of points converted from the observed scores of measures mentioned above in reference to standerd. These items are included in physical fitness test battery for the elderly developed by Ministry of Education, Science and Culture. Fortunately, the sample sizes, means and standard deviations of all items were filed as a data base in FACOM M780/20 computer in University of Tsukuba Information Processing Center since 1976. In order to determine more general trends of aging for these measures, the data of recent 4 years were pooled to compute the mean in each age; 30 through 59 years old, and each sex. Actually, the data were pooled in the term over 1984 and 1987. In the physical fitness survey by Ministry of Education, Science and Culture, the samples of the elderly people were extracted from 23 or 24 prefectures in each year, so a sample was extracted once from one prefecture by pooling the data of 2 years. Therefore, the sample from one prefecture were accounted twice by pooling data of 4 years, so the means computed by pooling data of 4 years could be assumed to be with much generalizability. But the data are cross-sectional.

Although all the items mentioned previously were analyzed, the discussion was limited to body weight, agility(side step), power(vertical jump), muscular strength(grip strength) and physical fitness as a whole indicated by physical fitness score, because number of pages are limited.

In order to determine what functions of t; age, can be fitted appropriately to their distance curves, polynomials of lst to 10th orders, logistic function, and several types of exponential functions were attempted to fit them, because several studies utilized some of these functions to fit the growth and development distance curves.[3,12] However, logistic function and exponential functions were found worsely fitted the deterioration trends than polynomials by evaluating the residuals. Moreover, the deterioration trends of physical fitness seemed not to show such a simple change as shown in logistic or exponential function and to have more inflexion points than they have. Then, polynomials of some order were attempted to fit the distance curves. The criteria used for determining the order of polynomial were standard error of estimate and randomness of residuals which was checked by Durbin-Watoson ratio and auto-correlation. Actually, the following procedures were applied.

(1) The polynomials of lst to 10th order were determined.

(2) The residuals were computed in polynomial of each order for each age and sex.

(3) Standard error of estimate(SEE), DW-ratio and auto-correlation were computed for polynomial of each order.

(4) Then, these three statistics were compared between polynomials of different order to find the order which gives the least SEE and acceptance of randomness assumption of residuals.

Polynomial of n-th order may have(n+1) parameters, so it is rather complicated to interprete their meanings, and, even if they could be interpreted, the comparison of parameters between different measures has no significance

because polynomial is determined so as to fit the actual distance curve but not the standardized distance curve.

Then, the first and second derivatives were determined and their curves were investigated to find the informations concerning velocity and acceleration of deterioration trends. In order to find the inflxion points, the 2nd derivative was put zero and solved. These roots may give the turning ages when the deterioration trend changes into sharper trend or slower; so-called inflexion point.

3. Results

(1) Determination of order of appropriate polynomial.

The upper half of table 1 shows the standard errors of estimate for polynomials of lst to 10-th order fitted in each measure for male.

＊＊ shows the least SEE among 10

Table 1 SEE, DW-ratio and auto-correlation for checking fittness of polynomials to deterioration trends of physical fitness.

Order	B. weight	Agility	Power	G. strength	P.F. score
1	.40859	.27180	.29938	.52813	.97775
2	.21590	.24835	.27130	.18205	.47345
3	.18915	.13965	.12975	.16706	.43805
4	.18653	.13621	.12714	.16360	.37456
5	.18598	.11145	.12348	.16267	.34805
6	.18579	.10698＊＊	.12223	.15960＊＊	.34515＊＊
7	.18410＊＊	.11369	.12190＊＊	.16124	.35052
8	.23593	.10899	.12756	.17368	.39052
9	.19217	.10802	.12390	.16500	.34878
10	.19996	.10910	.12254	.16960	.34802
DW-ratio	2.35269	2.36460	2.33151	1.96346	1.82816
Auto-cor.	−.19505	−.20530	−.17255	−.00203	.07560
1	.38415	.30963	.26464	.43010	1.68098
2	.15405	.14327	.17986	.14653	.55364
3	.13217	.14205	.18687	.14580	.43885
4	.12002	.13222	.12273	.11375	.38273
5	.11791	.12675	.11852	.11315	.38155
6	.11725＊＊	.12658＊＊	.11272＊＊	.10958＊＊	.37800＊＊
7	.11895	.13297	.11577	.11182	.38062
8	.13726	.12849	.11911	.11112	.38833
9	.11833	.12911	.11825	.11246	.38097
10	.11820	.13015	.10944	.11352	.38412
DW-ratio	2.09372	1.74162	1.97232	1.97739	1.91115
Auto-cor.	−.14014	.10695	−.00062	.15650	.17870

Note 1) The upper half of table shows the statistics of male and the lower half those of female.
2) Order means order of polynomial.
3) DW-ratio stands for Durbin-Watoson ratio and Auto-cor. for auto-correlation.
4) B. weight stands for body weight, Agility for side step, Power for vertical jump. G. strength for grip strength, P.F. score for physical fitness score.
5) ＊＊ stands for minimum standard error of estimate.
6) Values of DW-ratio and auto-correlation correspond to the values computed with residuals by polynomials showing minimum standard error of estimate.
7) The significance levels are .35501 at $\alpha=0.05$ and .4558 at $\alpha=0.01$, so all auto-correlations are not significant statistically.

Table 2 Example of polynomial chosen to fit the deterioration trend of physical fitness elements.

	Male		Female	
	B. weight	P.F. score	B. weight	P.F. score
* 1	7	6	6	6
a_0	65.1001892	79.1195679	51.7235870	76.4092255
a_1	.0500794351	−1.30547714	.0434059016	−.864781737
a_2	−.0204166025	−.0045142248	.0095970556	.0279746689
a_3	.0015863245	.0016526263	−.0006027976	−.0008014585
a_4	−.0000422017	−.0000545397	.0000295140	−.0002294398
a_5	−.0000010877	−.0000020972	−.0000014108	.0000118082
a_6	.0000000717	.0000000711	.0000000242	−.0000001601
a_7	−.0000000010			

Note 1) $Y=a_0+a_1t+a_2t^2+\cdots\cdots a_kt^k$, where $t=(age-30)$.
2) * 1 stands for order of polynomial chosen.

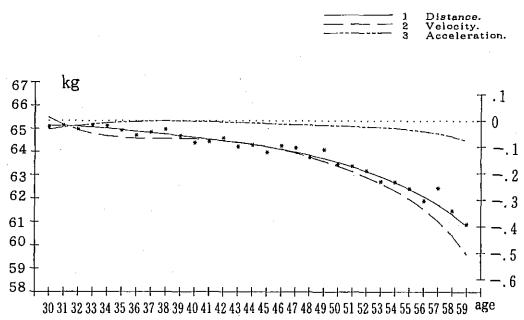

Fig. 1 Distance. Velocity. Acceleration curves of Body weight, Male

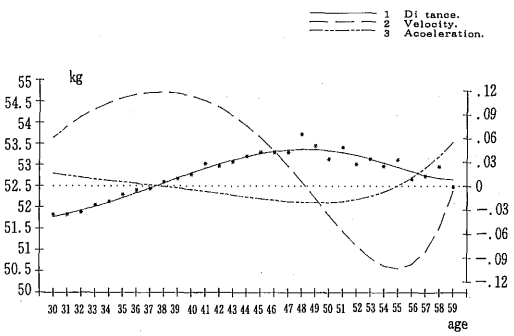

Fig. 2 Distance. Velocity. Acceleration curves of Body weight, Female

polynomials, and the DW-ratio and auto-correlation corresponding to the least SEE in each measure. SEE and auto-correlations show that polynomial of such order as showing the least SEE produced random residuals in all measures. The lower half of table 1 shows the same kinds of informations for female. Thus, the polynomials giving the least SEE were chosen to fit the deterioration trends of physical fitness elements chosen in this study. Although the parameters are not so interested in for the investigation intended in this study, two kinds of determined plynomials are shown as examples in table 2. All parameters are described in the form of F15. 10, because the terms of higher order may influence much to the estimated value even if their parameters are very small.

Standard errors of estimate show that all the deterioration trends could be fitted considerably well by polynomials of these orders chosen in table 1.

(2) Body weight

Fig. 1 and Fig. 2 show the distance, veloclity and acceleration curves of polynomials of 7th order for male and 6th order for female, and the actual mean of each age;30 through 59 years old.

The acceleration curve of male does not intersect the Y=0 line. This means the deterioration curve does not have any inflexion points in the term over 30 and 59 years of ages. The second derivative; acceleration, is negative and the first derivative is also negative. This suggests that body weight decreases clearly with

Table 3 Number of real roots and their corresponding ages. in the term over 30 and 59 years of ages

Sex	Male			Female		
Item	* 1	* 2	Ages	* 1	* 2	Ages
B. weight	7	0		6	2	37.8, 55.0
Agility	6	3	31.5, 44.7 54.7	6	3	33.5, 37.1, 53.7
Power	7	2	46.2, 55.8	6	3	37.8, 48.8, 55.3
G. Strength	6	1	36.4	6	3	36.4, 50.4, 55.5
P.F. score	6	2	39.5, 53.8	6	3	33.5, 50.5, 56.8

Note 1) *1 stands for order of polynomial chosen.
2) *2 stands for number of real roots when putting second derivative of polynomial zero.
3) B. weight stands for body weight, Agility for side step, Power for vertical jump, G. Strength for grip strength, and P.F. score for physical fitness score.
4) Ages are corresponding to the real roots.

aging in male. The velocity curve, however, shows that the decreasing velocity is a little large up to 34 years old and then it becomes rather constant up to 45 years of age, and then it is getting larger with aging up to 59 years of age. Moreover, it can be inferred that the deterioration trend of body weight is accelerated all the way up to 59 years old.

Fig. 2 shows a quite different trend from that of male mantioned previously. The acceleration curve intersects the Y=0 line at 2 points; the corresponding ages are 37.8 and 55.0 years of ages, as shown in table 3. The second derivative is positive before 37.8 years of age and negative between 37.5 and 55.0 years of ages, and then it turns to be positive again after 55.0 years of age. The first derivative is positive before 48.5 years of age, so body weight increases up to 48.5 years old in female. Moreover, this increasing trend is accelerated up to 37.5 years of age, because of positive second derivative, and then, it is decelerated up to 48.5 years of age.

After 48.5 years of age, body weight turns to decrease and this decreasing trend is accelerated up to 55.0 years of age, because of negative second derivative, and thereafter, the second derivative turns to be positive, so it can be inferred that this decreasing trend is decelerated. This is also verified by the decrease of decreasing velocity shown in the first derivative curve.

(3) Agility; side step

Fig. 3 shows the distance, velocity and acceleration curves of agility in the term over 30 and 59 years of ages for male. As far as the distance curve investigated, only a certain gradual deterioration trend could be understood. The second derivative curve intersects the Y=0 line at 3 points; the corresponding ages are 31.5, 44.7

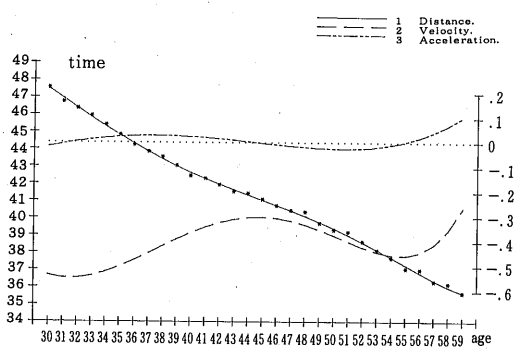

Fig. 3 Distance. Velocity. Acceleration curves of Agility, Male

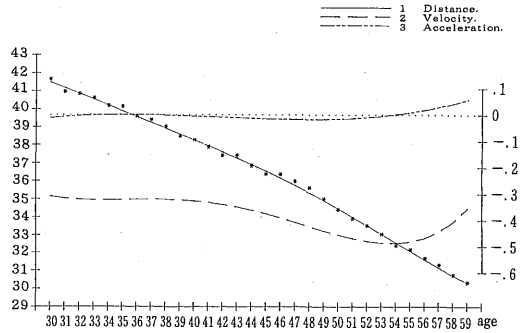

Fig. 4 Distance. Velocity. Acceleration curves of Agility, Female

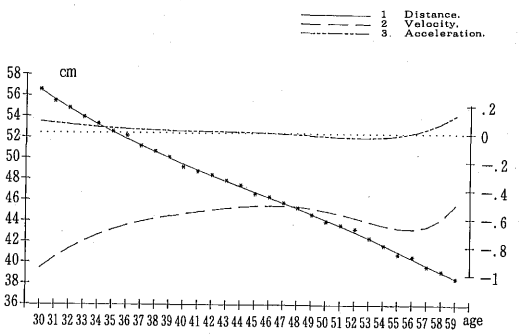

Fig. 5 Distance. Velocity. Acceleration curves of Power-V.J., Male

and 54.7 years of ages. Thus it can be inferred that the deterioration trend may change its tendency at these three ages. In other words, these three ages are so-called critical ages. Until 31.5 years of age, the second derivative is negative, so it can be inferred that the deterioration trend is accelerated. But, between ages of 31.5 and 44.7, the second derivative is positive and the first derivative increases, so this suggests that the deterioration trend is decelerated. This can be evidenced by that the distance curve turns to be concave upwards between these ages. Then, between 44.7 and 54.7 years of ages, the second derivative is negative, so the decreasing velocity is increasing. After 54.7 years of age,the second derivative is positive and increasing, so the decreasing velocity decreases. This suggests that the deterioration trend is decelerated after 54.7 years of age.

Fig. 4 shows the distance, velocity and acceleration curves in female. Overall trend is mostly similar to that of male. However, the ages corresponding to the inflexion points are 33.5, 37.1 and 53.7 years of ages. They are only a little different from those of male. But the variation interval of first derivatives is larger in male than in female, so it can be inferred that the deterioration trend is almost similar in both sexes but the male's trend is likely to show a little ,more extent of variation than in female.

(4) Power; vertical jump

Fig. 5 shows the distance, velocity and acceleration curves of power measured by vertical jump in male. As far as only the distance curve investigated, it deteriorates gradually. However, the second derivative curve intersects the Y=0 line at 2 points; the corresponding ages are 46.2 and 55.8 years of ages. In other words, the deterioration trend has two critical ages at which the caracteristics of deterioration changes. Until 46.2 years of age, the second derivative is positive, so it can be inferred that the deterioration trend is decelerated. This is also verified by the increases of velocity; in other words, the decrease of decreasing velocity, as shown in Fig. 5. Then, between 46.2 and 55.8 years of ages, the second derivative is negative, so it can be inferred that the deterioration trend is accelerated, but after 55.8 years old the second derivative turns to be positive again, so it may suggest that the deterioration trend is decelerated again.

Fig. 6 shows those of Female. It is easily understood that the deterioation trend of female is a little more complicated than that of male. However, as far as only the distance curve is compared between both sexes, it is rether hard to induce the difference between them. The second derivative curve intersects the Y=0 line at 3 points; they are corresponding to 37.8, 48.8 and 55.3 years of ages. Before 37.8 years of age, the second derivative is

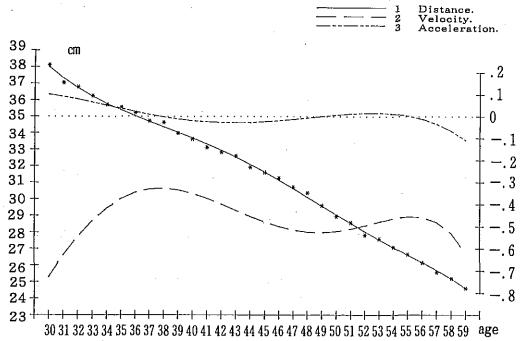

Fig. 6 Distance. Velocity. Acceleration curves of Power-V.J., Female

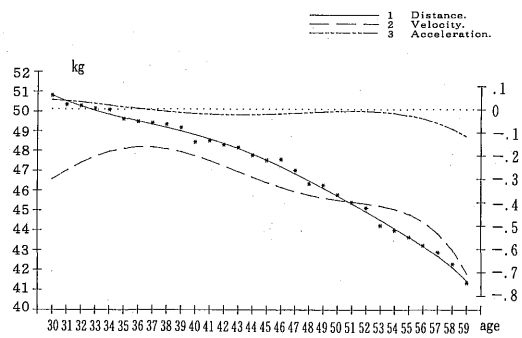

Fig. 7 Distance. Velocity. Acceleration curves of Strength-G.S., Male

positive, so the first derivative increases. Thus, it can be inferred that the deterioration trend is decelerated. This can be recognized by that the shape of distance curve is concave upwards in this age term.Then, between 37.8 and 48.8 years of ages, the second derivative is negative and the first derivative is decreasing, so the distance curve is convex upwards. This shows that the deterioration trend is accelerated between 37.8 and 48.8 years of ages. Between 48.8 and 55.3 years of ages, the second derivative becomes positive again, so the deterioration trend is decelerated again. After 55.3 years of age, the second derivative turns to be negative, so it can be inferred that the deterioration trend is accelerated. Thus, male shows two critical ages but female shows three, so it can be concluded that the deterioration trend can be divided into three phases in male and four phases in female. And, the deterioration trend continues with deceleration and acceleration repeated in the term over 30 and 59 years of ages.

(5) Strength; grip strength

Fig. 7 shows the distance, velocity and acceleration curves in male. The acceleration curve intersects the Y=0 line at only one point; the corresponding age is 36.4 years of age. Until 36.4 years of age, the second derivative is positive, so velocity increases. In other words, the deterioration velocity decreases. There-

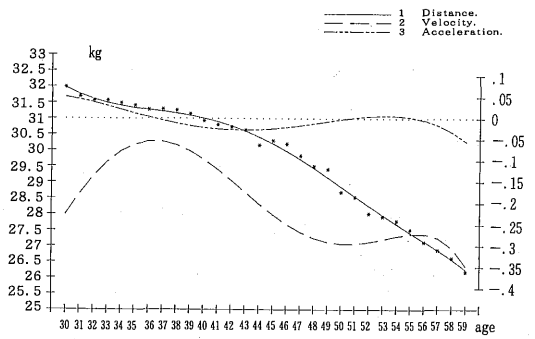

Fig. 8 Distance. Velocity. Acceleration curves of Strength, Female

after, the second derivative is negative all the way. This suggests that the deterioration trend is accelerated. However, after 53 years of age, the deterioration velocity is going to be larger a little sharply, as shown in Fig. 7, so the deterioration trend is accelerated a little more than before that age.

Fig. 8 shows those of female. The second derivative curve intersects the Y=0 line at 3 points; the corresponding ages are 36.4, 50.4 and 55.5 years of ages. Until 36.4 years old, the second derivative is positive, so the deterioration velocity decreases. This suggests that the deterioration trend is decelerated up to 36.4 years old. In the term over 36.4 and 50.4 years of ages, the second derivative is negative and the deterioration velocity is going to be larger, so it can be inferred that the deterioration trend

is accelerated up to 50.4 years of age. And the second derivative becomes positive after 50.4 years old and positive acceleration continues up to 55.5 years old, but its value is not so large. Therefore, the deterioration trend is decelerated only a little in this age term. This can not be recognized so clearly, as far as only the distance curve taken. Probably such a change may be ignored. After 55.5 years of age, the second derivative becomes negative again, and the decreasing velocity gets larger rather sharply, so it can be inferred that the deterioration trend is accelerated after 55.5 years old. Compared female with male, more variable trend may be recognized in female.

(6) Overall physical fitness; physical fitness score

This is evaluated by physical fitness score that is sum of points converted from observed score in reference to standard.

Fig. 9 shows the distance, velocity and acceleration curves of male. The second derivative curve intersects the Y=0 line at 2 points; the corresponding ages are 39.5 and 53.8 years of ages. The second derivative is positive up to 39.5 years of age, but its deceleration is to such small extent as this trend is very likely to be linear. In the term over 39.5 and 53.8 years of ages, the second derivative truns to be negative, so it can be inferred that the deterioration trend is accelerated in this age term, and the local

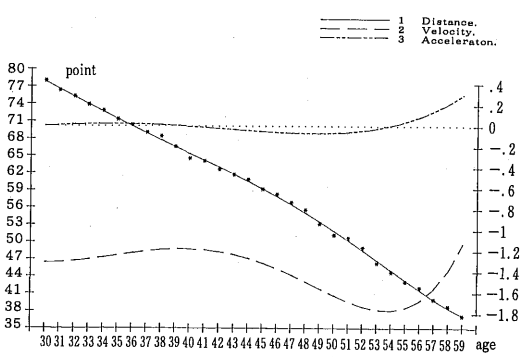

Fig. 9 Distance. Velocity. Acceleration curves of P.F. soore, Male

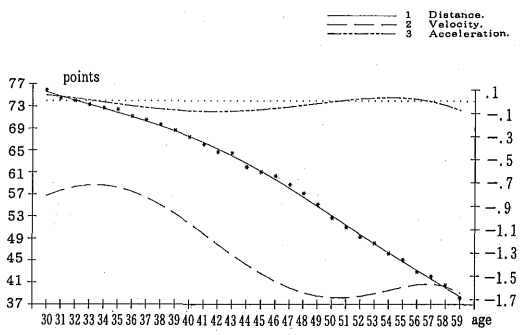

Fig. 10 Distance. Velocity. Acceleration curves of P.F. soore, Female

maximum of deceleration velocity appears at 53.8 years old. Hereafter the acceleration turns to be positive, and the absolute value of second derivative is maximum in the term over 30 and 59 years old, so the deterioration trend is decelerated so sharply after 53.8 years old.

Fig. 10 shows those of female. The acceleration curve intersects the Y=0 line at 3 points; the corresponding ages are 33.5, 50.5 nad 56.8 years old, and the second derivative is positive until 33.5 years old, so the deterioration trend is decelerated. In the term over 33.5 and 50.5 years old, the second derivative is negative and the velocity curve shows that the deterioration velocity is increasing, so it can be inferred that the deterioration trend is accelerated in this age term. The maximum deterioration velocity appears at 50.5 years of age. Therefore, the deterioration trend changes at this age, because the second derivative turns to be positive. That is,the deterioration trend is a little decelerated, because the second derivative is so small; that is, acceleration is to a small extent. However, this deceleration continues up to 56.8 years old, and thereafter, the second derivative becomes negative, again, so the deterioration trend is accelerated again. thus, the deterioration trend of female shows the deceleration and acceleration repeatedly in the term over 30 and 59 years of ages.

(7) Comparison in deterioration trend between different physical fitness elements

Table 4 aging trends of physical fitness elements in the aged people.

	Item \ Age	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59
M	Body weight	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−
a	Agility	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	−	−	−	−	−	−	−	−	−	−	+	+	+	+
l	Power	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	−	−	−	−	−	−	−	−	+	+	+	+
e	Strength	+	+	+	+	+	+	+	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−
	P.F. score	+	+	+	+	+	+	+	+	+	+	−	−	−	−	−	−	−	−	−	−	−	−	−	−	+	+	+	+	+	+
F	Body weight	+	*	+	*	+	*	+	*	+	*	−	*	−	*	−	*	−	*	−	*	−	−	−	−	−	−	+	+	+	+
e	Agility	−	−	−	−	−	0	0	0	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	+	+	+	+	+	+	+	+
m	Power	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	−	−
a	Strength	+	+	+	+	+	+	+	−	−	−	−	−	−	−	−	−	−	−	−	−	+	+	+	+	+	+	+	−	−	−
l	P.F. score	+	+	+	+	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	+	+	+	+	+	−	−	−
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Note 1) " − " stands for that deterioration trend is accelerated.
2) " + " stands for that deterioration trend is decelerated.
3) "+ * " stands for that increasing trend is accelerated.
4) "− * " stands for that increasing trend is decelerated.
5) " 0 " stands for that deterioration trend is almost linear.
6) Agility is measured by side step, Power by vertical jump, Strength by grip strength, P.F. scoree stands for physical fitness score.

Some characteristics of deterioration trends of physical fitness were investigated so far. Except female's body weight, all the elements of physical fitness chosen in this study show the deterioration trend consistently in the age term over 30 and 59. But their characteristics; acceleration or deceleration and velocity, are not necessarily similar. Table 4 shows the aging trends of physical fitness elements chosen in this study. Body weight shows quite different from those of other elements in both sexes. The acceleration of deterioration trend begins in most of elements later in male than in female, and it lasts up to the middle of fifties in male but up to later half of forties or before half of fifties in female. In female the decelerated deterioration trend is likely to appear after the later half of forties and then it turns to be an accelerated deterioration again. In male, however, such accelerated deterioration trend seems not to appear after the decelerated deterioration trend appears in fifties for most elements, except strength that shows an consistently accelerated deterioration after late half of thirties.

In male's body weight and strength, the accelerated deterioration trend seems to continue up to 59 years old consistently since it begins. Even so, after later half of fifties, the degree of acceleration of deterioration may be larger than before. Except body weight, the age interval in which the accelerated deterioration trend appears commonly in all elements of physical fitness is 47 to 53 years of ages in male and 37 to 48 years of ages in female. Thus, as far as the elements chosen in this study concerned, these age intervals conld be considered as the term in which physical fitness lowers critically for the elderly people.

4 . Discussion and conclusions

Most of physical fitness elements reach their peak levels in the twenties.[1),4),11),15)] Thereafter, man begins to recognize the deterioration of his own physical fitness.[1),11)] Even before 30 years

old, however, a certain deterioration begins in most organs, their functions and physical fitness,[1] but most of people do not recognize such deterioration, because people can behave or participate in exercise in nearly similar way as they could in younger days. This is because being young can compensate the deterioration of physical fitness partly psychologically and physiologically.[1),11)] Thus, except female's body weight, it is very reasonable that all physical fitness elements chosen in this study showed the consistent deterioration trends in the term over 30 and 59 years of ages for both male and female.

Shephard, R.J. (1986)[15] reported that the function of males was well preserved to 40-49 years but there was a 19% loss of function by 60-69 years. But he did not investigate how the deterioration is going in these elderly days. This study, however, pointed that the deterioration may begin in thirties and the peak level of physical fitness can not be preserved up to forties, although the deterioration trends are decelerated in various physical fitness elements up to 36 to 46 years.Incidentally the comparison in means of grip strength and vertical jump between twenties, thirties, forties and fifties with the means reported in 1986 report of physical fitness survey by Ministry of Education, Science and Culture shows 90.0, 79.5, and 70.0 for thirties, forties and fifties in vertical jump and 103.3, 98.5, and 90.7 in grip strength for male with putting the means of twenties 100.[13] Thus, in grip strengh, Shephard's inference(1986) concerning Canadian is appropriate to Japanese elderly male.

For female, Shephard pointed that the maximum of grip strength was observed at an age of 20-29 years.[15] The same report by Ministry of Education, Science and Culture shwed that the maximum of grip strength was observed in the thirties. Shephard(1986) also reported that grip strength began to decline in the 50 to 59 year age group. However, in this study, the means of thirties and forties were greater than that of twenties in grip strength, but the decline began at thirties in Japanese female.

Furthermore, Nakamura, E. (1986)[14] pointed that the rate of change in these functions and physical fitness with aging varies among functions and subdomains of physical fitness. This study can give a certain evidence on his opinion on the changing trend of physical fitness with aging. Moreover, this study can give more informations on how different the aging processes are in various physical fitness elements. Matsuura, Y. (1982)[12] showed the aging trends of various physical fitness elements and discussed in his publication. He, however, did not discuss so precisely on such characteristics of aging trends as discussed in this study. Furthermore, as cited from Shephard and Nakamura previously, and as far as various articles investigated, the deterioration velocity and acceleration have not been discussed.

Then, the following conclusions were obtained.

1) In the aging trend of several physical fitness elements chosen, except female's body weight, the deterioration trends were recognized in the term over 30 and 59 years of age.
2) In this age term, the deterioration trends were not so simple as linear in all physical fitness elements; that is, the trend is decelerated in some term and accelerated in other term repeatedly.
3) The age term in which the deterioration trend is accelerated is the late forties to early fifties for male but the late thirties to late forties and after early fifties for female. Comparatively speaking, these age terms may stand for the critically decreasing processes of physical fitness for the elderly people.
4),The age term in which the deterioration trend is decelerated is the thirties to early forties and the late fifties for male but the early thirties and the early fifties for female.
5) In female, the increasing trend was recognized up to 48 years of age only in body

weight, and this trend was accelerated up to 37 years of age.

6) More inflexion points of distance curve; deterioration curve, were found in female than male, so it could be inferred that the deterioration trends were more complicated in female than in male.

Actually, the deterioration trend of physical fintess is much influenced by various conditions, such as socio-economical, occupation and some characteristics of way of life; daily practice of physical exercises, food intake habit, rest and sleep, and so on. Thus, taking these conditions into consideration, the deterioration trend of physical fitness should be investigated in further studies.

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