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Anthropometric, functional and explosive strength characteristics of women over 50 physically active, from Bogota city, Colombia.

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Características antropométricas, funcionales y de fuerza explosiva de mujeres mayores de 50 años físicamente activas de la ciudad de Bogotá-Colombia

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Abstract

Aging as degenerative process induces significant changes in the elderly affecting the level of functional independence, quality and lifestyle. *Methods:* This study was conducted with 102 women physically active and without risk factors. Anthropometric tests, of functional independence and explosive strength were applied. *Results:* Average age 60.08 ± 5.35 years, body mass index: 26.81 ± 3.91, percentage of fat: 52.45 ± 4.75, percentage of muscle mass: 37.24 ± 6.77, tests of functional independence: maximum speed (30 meters): 9.39 ± 1.92 s, speed-agility (30 meters): 12.93 ± 1.59 s and dynamic balance (6 meters): 21.97 ± 8.01 s. Explosive Strength (Bosco test): *Squat Jump:* 12.23 ± 3.05 cm, *Countermovement Jump:* 13.18 ± 3.04 cm and *Countermovement Jump Arm swing:* 14.80 ± 4.01 cm. *Conclusion:* The statistical relationships found between body composition, explosive strength and functionality tests, are an important diagnostic tool and control that can improve the intervention models with elderly.

Key words: antropometric, functionality, explosive strength, independence, lifestyle.

Introduction

The aging process involves a series of physiological degenerative changes in the organs and systems that make up the human biological group, which result in a general deterioration of physical condition with strong impact on morbidity and mortality [1, 2]

This phenomenon impacts markedly the health spending in countries of low, medium and high development, whether by the low percentage of funds in relation to gross domestic product designed to address the associated diseases, or in special cases, by the presence of sufficient resources, but misguided, since they are intended to treat diseases apart from prevention programs, models that reveal more effective in controlling the phenomenon described in the medium and long term [3-5].

These changes in cardiovascular, metabolic, endocrine, hematologic, neural and muscle kind associated with aging (multisystemic damage) makes specifically complex to implement healthy strategies and reveal the importance of taking research actions in health policy in different countries that feed the "promotion and prevention" programs so to ensure their effectiveness within the public health model [1]

What has been said force us not only to understand the proposed theories associated with aging [2], but also to analyze the impact on the general homeostasis that the suggested models inform by incorporating new and varied intervention strategies, considering the disproportionate increase in percentage rates of population over fifty years, the declining birth rate and the projections of life.

However, a key component that enables to evaluate the impact of aging on individual health status of people aged 50 years or over, refers to the levels of functional autonomy and ability to cope with the mechanical stresses imposed on a daily basis (climbing stairs, walking, running, lifting or carrying, among others).

The mentioned factor is strongly affected by the changes of the muscular system related to the loss of fast twitch fibers ***(FT),*** increase of percentage of slow Twich ***(ST),*** reduction of nerve activation, neuronal motor death (alpha), changes in patterns of intra-inter muscular coordination, among others, that together with the style and sedentary lifestyle accelerate the aging process and reduce the life expectancy [6-9].

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In this regard, although various strategies are emerging worldwide where increases in maximal strength, explosive strength, functionality and style of life are shown, demonstrating the importance of exercise as a therapeutic tool [10-15], there are insufficient data to adjust, dismiss or assimilate fully diagnostic control tests for these processes, which creates a major problem because it can not establish the impact of the models launched, its preventive capacity, as well as their effectiveness in preventing diseases of aging.

If the above is that several authors [12, 13, 16-20] are reporting a relationship not only between the loss of expression of maximal strength, but also explosive strength conditioning the ability of functional independence by having a more direct impact with the mechanics of everyday tasks, we see then a strong vacuum in the control models applied to analyze the state of fitness, since it is ignored the unique characteristics of the physiology of aging, which is critical to accurately establish the objectives and principles of progression for these activities. In this sense, the present study applies body composition tests, speed-agility, smooth speed, dynamic balance and explosive strength in physically active women, participants in the physical activity program for elderly sponsored by the Instituto Distrital de Recreación y Deportes, Bogotá city (Colombia). The objectives are designed to analyze the relationships between different tests of explosive nature and function of participant active women in a recreational sports program, with the intention not only to characterize and establish a healthy state, but also to determine the diagnostic capability and controlling them in a single intention to increase the theoretical support of these models proposed assessment.

Methods

463 participant women were interviewed in the programs promoted by the District Institute of Recreation and Sport-Bogota (Instituto Distrital de Recreación y Deporte-Bogotá) responding as stipulated by the American College of Sports Medicine (ACSM) and concerning the criterion of biomedical group [21].

In this regard it should be mentioned that of the 463 women to whom it was applied the clinical evaluation, 361 were excluded from the process and demonstrating that while carrying a continuous practice of physical activity not less than two days per week, they had high risk factors related to a thirty-one percent of bone and joint disorders (osteoarthritis, arthritis, etc.), thirty-seven percent of cardiovascular problems (uncontrolled hypertension, heart failure, varicose veins, among others) and thirty-one percent of high fat percentage and body mass index.

Therefore, from the total of female leaders only 102 met the criteria associated with minimal physical practice of two days per week (gymnastics, dancing, jogging, tai chi, etc.) for a period not less than one year, so as the medical clearance for participation in functional tests that will discard any unnecessary risk.

The study was authorized by the ethics committee of the Universidad Santo Tomas Bogota and attended the criteria suggested in the Declaration of Helsinki which is still actual valid from 1964 to date. To start the process of selecting and organizing of groups to testing, subjects provided an informed consent form detailing the objectives, procedures and inconveniences of research and their confidential use.

Potential candidates were interviewed and assessed clinically using the following criteria: cardiovascular, respiratory, musculoskeletal, metabolic, vascular diseases, as well as spine and upper or lower limb deformities, amputations, prosthesis, treatment with steroids, which in some how could alter the behavior of the variables to measure or jeopardize the health of participants.

Taking the statistics we used a non-probability and intentional sampling taking into account the difficulties of access to a population that meet the above requirements, maintaining a total "n" of 102 women for whom the different tests were administered and those characteristics are in **Table 1**.

Table 1. General profile of adults over 50 years of age participating in the IDRD-2010 program.

Variables	Average	Standard Deviation	Confidence Interval LI	LS	Minimum	Maximum	Percentile 25	Percentile 50	Percentile 75
Age	60.08	5.35	58.92	61.23	50	70	56	61	64
Height (cm)	1.55	0.06	1.54	1.57	1.45	1.73	1.51	1.55	1.60
Weight (kg)	64.83	9.36	62.81	66.85	45	96.80	56.80	64.20	70.05
BMI	26.81	3.91	25.96	27.66	19.75	40.82	24.18	26.48	28.30

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Fat Mass (kg)	34.14	6.19	32.80	35.48	20.38	51.71	29.95	34.34	37.97
Body Fat percentage (%)	52.45	4.75	51.42	53.49	35.46	60.19	41.80	43.51	45.05
Muscle Mass (Kg)	33.91	3.68	33.11	34.71	16.36	35.71	32.79	36.57	40.35
Muscle Mass percentage (%)	37.24	6.77	35.77	38.71	26.43	49.01	21.58	23.59	26.60

LI: Limit Inferior, LS: Limit Superior, BMI: Body Mass Index.

Evaluation tests:

Evaluation tests related to body composition

The anthropometric assessment followed the rules and guidelines established by the International Society for the Advancement of Kinanthropometry (ISAK) and the Cineantropometria Spanish Group (GREC) that have been recorded in the Esparza text [22]. The measured variables were: weight, height, skinfolds (biceps, triceps, subscapular and supracrestal), arm, thigh and leg circumference, and diameters of humerus and femur. We calculated the percentage of body fat mass according to Bencke and Wilmore equation [23], body density by the formula of Durnin and Womersley [24], muscle mass in response to Doupe, [25], bone mass by Rocha equation [26], the residual mass with Würch equation [27] and Quetelt's body mass index [28]. The instrument used was a Holtain plicometer®, Stanley measure tape®, Berfer type caliper®, Faga type stadiometer®, Tanita model scale®.

Evaluation tests related to functionality

Test for Assessing Dynamic Balance *(Tandem Walk "TW")* is a battery validated by Nelson et al [29], in which the individual must go back a distance of 6 meters along a straight line drawn in the ground. Position is considered a correct output when both feet are together and in touch, when he moves back a foot to touch the back of the heel of his supporting foot. The course must be done as quickly as possible and to take long steps, to go out of the straight line and not touching the later face of the support foot that is being used are considered failures.

Speed-Agility Test 30 m *(Shutle Run test "SRT")* is a validated instrument by Ramirez and colleagues [12], which consists of crossing a straight line path 30 meters. The distance was divided into 4 runs of 7.5 meters completed continuously until a total of 30 meters in the shortest possible time. Measure was always taken off and turning on the right side, seeking to control the quality of measurement, and points were established and visible to the test, restricting the set of departure and arrival. Each subject received an instruction prior to testing and made three attempts, which took the most representative for further analysis. All records were taken using two Kronus digital stopwatches®, polar brand heart rate monitors® and the distances were measured with a Stanley tape®.

Smooth speed test of 30 m: adapted from Grosser et al suggested test [30] aimed at assessing the speed of reaction and maximum cyclical speed (especially acceleration rate), a line was marked with three points and -2, 0 and 30 meters, -2 point being the beginning of taking the heart rate, 0 point of taking the initial time and the end point 30 of the same with heart rate recording. While it is not very common to use these tests with over 50 years, it was included given the nature of the study, the author's previous research and the established coefficients of 0.82 to 0.90 for untrained persons warned by Fetz et al since 1976 [31], which have not been compared with subjects with the characteristics, age and gender contained in the present study, discarding information that could be useful from the functional and biomechanics standpoint.

Evaluation tests related to the explosive force

To the knowledge of the force generated by the lower limbs, Bosco test was applied, using different types of jump and varying the joint angle [32].

Explosive strength was measured by the subject's response to a vertically maximum jump *(squat jump* [SJ]: starting from a position of knee flexion of 90 degrees, with hands on hips, jumps high center of gravity), a maximum countermovement jump *(countermovement Jump* [CMJ]: standing with full extension of knees and hands on hips, is lowered to 90 ° and jumps) and maximal countermovement jump and coordination of the upper limbs *(countermovement Jump Arm swing* [CMJas]: similar to above but with the collaboration of the upper limbs for greater height). 3 to 5 per test jumps were carried out (SJ, CMJ and CMJas) and the more representative height, flight time and speed were taken for further analysis. In measuring the explosive force a jumping mat AXOM JUMP Technology® was used.

Statistical analysis

In all variables the test of goodness or normality adjustment was applied through the Kolmogorov-Smirnov, Shapiro Wilk and graph distribution with normal curve. Differentiation levels were set at 5% with a confidence interval of 95% and was considered statistically significant p values <0.05.

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Table 2. Descriptive analysis of functional tests.

Variables	Average	Standard Deviation	Confidence Interval LI	Confidence Interval LS	Minimum	Maximum
Speed 30 m						
Heart rate (a) (beats x minutes)	102.36	16.13	98.88	105.84	64	160
Heart rate (b) (beats x minutes)	126.90	13.22	124.05	129.75	99	156
Time (s)	9.39	1.92	8.95	9.78	6.62	19.10
Speed-agility 30 m						
Heart rate (a) (beats x minute)	93.97	12.65	91.24	96.70	63	125
Heart rate (b) (beats x minute)	122.30	15.61	118.93	125.67	71	163
Time (s)	12.93	1.59	12.59	13.28	8.58	18.10
Dynamic Balance 6 m						
Time (s)	21.97	8.01	12.21	23.69	9.52	43.41

LI: Limit Inferior, LS: Limit Superior, a = Heart rate pre-test; and b=Heart rate pos-test.

Variables were correlated with body composition, functional and explosive strength, using the Spearman correlation coefficient and hypothesis test of the correlation, considering statistically significant p values <0.05.

The SPSS® version 19 was employed for statistical analysis and Microsoft Office package for writing, database, tables design and graphs.

Results

Results related to body composition

The item-related data were consolidated in Table 1, which highlights the confidence interval for age, weight, BMI, fat mass and fat-free mass that allows to establish the exact location of values and own characteristics of the evaluated group. The information highlights that the process was concentrated in an age of 60.08 ± 5.3 years, an important aspect to consider in the discussion of the results.

Results related to the expression of functional independence.

The results of functional tests are presented in **Table 2**. Within these records the values marked by the speed at 30 meters, 30 meters speed agility and dynamic balance on 6 meters are important with parallel tracking of the cardiac response as a measure of overall cardiovascular control.

Results related to the expression of explosive force

The results of tests related to the expression of explosive strength are presented in **Table 3**. It is important to highlight the units for each of the terms of the protocol, and the maximum heights reached in relation to displacement speed, as these are key parameters to reflect the behavior of the neuromuscular system.

General profile correlations with explosive strength and functionality

Data are presented in **Table 4**. Values emphasize important relationships "p" and "r" among all the variables of general profile and CMJ. Another aspect to consider is the presence of no value "p" and "r" of interest in relation to dynamic equilibrium or when the variables are related to body fat percent, lean mass, or BMI with the considered rate expressions.

General profile correlations with explosive strength and functionality tests.

The correlation of functional and explosive strength is presented in **Table 5** separately for greater clarity in their interpretation. These highlights how they behave statistically the notions of speed-30 m and speed-agility 30 m; when they relate to the variables of explosive strength and the non-presence of relationships between data in lean muscle mass and the rest of other variables.

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Table 3. Descriptive analysis of explosive strength tests.

Variables	Average	Standard Deviation	Confidence Interval LI	LS	Minimum	Maximum
Squat Jump (SJ)						
Flight (ms)	313.42	40.36	304.71	322.12	200	384
Height (cm)	12.23	3.05	11.57	12.89	4.90	18.00
Speed (m/s)	1.54	0.20	1.49	1.58	0.98	1.88
Contramovement Jump (CMJ)						
Flight (ms)	322.92	52.54	311.59	334.26	200.72	415.28
Height (cm)	13.18	3.04	12.53	13.84	5.30	21.20
Speed (m/s)	1.59	0.19	1.53	1.63	1.02	2.04
Contramovement arm swing Jump (CMJas)						
Flight (ms)	343.96	48.17	333.57	354.35	200	463
Height (cm)	14.80	4.01	13.94	15.67	4.90	26.30
Speed (m/s)	1.69	0.23	1.64	1.74	1.02	2.27

LI: Limit Inferior, LS: Limit Superior

Table 4. Correlations of general profile variables with those of explosive and functionality strength. Where SJ= vertical jump; CMJ= jump with contramovement; CMJas= jump with contramovement and arms balance.

General Profile	Explosive Strength	Significance level	Functionality	Significance level
Age (years)	Time SJ (ms)	r= -0.35; p= 0.001	Speed 30 (s)	r= -0.48; p= 0.0001
	Height SJ (cm)	r= -0.35; p= 0.001	Speed-agility (s)	r= -0.40; p= 0.0001
	Speed SJ (m/s)	r= -0.31; p= 0.004	Dynamic balance	NS
	TimeCMJ (ms)	r= -0.31; p= 0.004		
	Height CMJ (cm)	r= -0.33; p= 0.002		
	Speed CMJ (m/s).	r= -0.37; p= 0.002		
	Time CMJas (ms)	r= -0.40; p= 0.0001		
	Height CMJas (cm)	r= -0.41; p= 0.0001		
	Speed CMJas (m/s)	r= -0.47; p= 0.0001		
BMI	Time SJ (ms)	r= -0.63; p= 0.001	Speed 30 (s)	NS
	Height SJ (cm)	r= -0.66 p= 0.001	Speed-agility (s)	NS
	Speed SJ (m/s)	r= -0.61; p= 0.001	Dynamic balance	NS
	Time CMJ (ms)	r= -0.57; p= 0.001		
	Height CMJ (cm)	r= -0.61; p= 0.001		
	Speed CMJ (m/s).	r= -0.55; p= 0.002		
	Time CMJas (ms)	r= -0.67; p= 0.0001		

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	Height CMJas (cm)	r= -0.67; p= 0.0001		
	Speed CMJas (m/s)	r= -0.61; p= 0.0001		
Fat percentage	Time SJ (ms)	r= -0.59; p= 0.001	Speed 30 (s)	NS
	Height SJ (cm)	r= -0.58 p= 0.001	Speed-agility (s)	NS
	SpeedSJ (m/s)	r= -0.56; p= 0.001	Dynamic balance	NS
	Time CMJ (ms)	r= -0.56; p= 0.001		
	Height CMJ (cm)	r= -0.56; p= 0.001		
	Speed CMJ (m/s).	r= -0.55; p= 0.002		
	Time CMJas (ms)	r= -0.65; p= 0.0001		
	Height CMJas (cm)	r= -0.64; p= 0.0001		
	Speed CMJas (m/s)	r= -0.60; p= 0.0001		

SJ = Squat Jump, CMJ = Contramovement Jump, CMJas = Contramovement arm swing Jump, BMI: Body Mass Index.

Table 5. Correlations between functionality and explosive strength variables.

Ítems taken in functionality	Explosive strength	Significance level
Speed-agility 30 m (s)	Time SJ (ms)	r= -0.52; p= 0.0001
	Height SJ (cm)	r= -0.52; p= 0.0001
	Speed SJ (m/s)	r= -0.46; p= 0.0001
	Time CMJ (ms)	r= -0.47; p= 0.0001
	Height CMJ (cm)	r= -0.47; p= 0.0001
	Speed CMJ (m/s).	r= -0.44; p= 0.0001
	Time CMJas (ms)	r= -0.52; p= 0.0001
	Height CMJas (cm)	r= -0.53; p= 0.0001
	Speed CMJas (m/s)	r= -0.43; p= 0.0001
Smooth speed 30 m (s)	Time SJ (ms)	r= -0.34; p= 0.002
	Height SJ (cm)	r= -0.33; p= 0.001
	Speed SJ (m/s)	r= -0.35; p= 0.001
	Time CMJ (ms)	r= -0.31; p= 0.003
	Height CMJ (cm)	r= -0.32 p= 0.002
	Speed CMJ (m/s).	r= -0.45; p= 0.001
	Time CMJas (ms)	r= -0.42; p= 0.0001
	Height CMJas (cm)	r= -0.43; p= 0.0001
	Speed CMJas (m/s)	r= -0.40; p= 0.0001

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Discussion

Discussion related to body composition

The average value of BMI of 26.81 ± 3.91 corresponds to healthy criteria described by authors such as Kyle et al [33], suggesting half limit of 25.9 ± 4, Moore and colleagues [34], revealing normal values of 27.8, not even differ from the study by Rodríguez et al [35], who described some variations between institutionalized and non-institutionalized older, a factor that somehow changes the lifestyle.

It is important to say that the parameter mentioned is particularly controversial when it is used in over fifty years, since although it is associated with health status, the variation in body behavior caused by sarcopenia or its weak association with premature mortality rates as suggested by the studies of Harris, Tayback and Grabowski [36-38], at variance with what is revealed by Bannerman and Jankowski [39,40]; they invite to use additional procedures in order to avoid interpretations and reflections of erroneous results.

On the other hand, the percentage of fat mass of 52.45 ± 4.75 found is higher than the offering Velásquez et al [41] in a Cuban sample (Female: 40.41%), as observed by Prado et al [42] in a Mexican community (women: 43.77%) and as reported by Rodriguez [35], in a larger Catalan population, noting that the equations of Siri and Brozeck were used in them for their calculation, which were applied in this study and excluded for overestimating values. However, it should be clarified that when looking at the percentiles, 75% of the elements are found in a figure below 45%, which while still a high figure is a common value found in these ages corresponding to the published records with other procedures such as bioimpedance used in studies of Kyle and Guerra [43, 44], suggesting a value of 40.5% for women aged 55-64 years an acceptable range in relation to age and physical condition.

Another interesting data is the one regarding muscle mass with a value of 33.91 ± 3.68 which is remarkably low and consistent with the losses reported in the study by Gonzales et al [45], (30.37 ± 7.83 lean mass) or less optimistic figures as revealed by Kyle [43] over 85 years using bioelectrical impedance, which warns of a sharp and rapid loss of muscle mass for the sample, although the value for the 50 percentile is at 36,57% and coincides with that published for the same age range. It should be clear that the intrinsic and extrinsic factors that may influence the phenomenon of loss of muscle mass are varied, but it is revealed decreases of 3 kilograms of muscle mass per decade after age 50 where neural type, structural and hormonal changes are involved that are being suggested in many studies and reviews such as Chapman and Ramirez [13, 20, 46].

Discussion related to the expression of functional independence

Another aspect evaluated is related to the expression of three components such as speed, speed-agility and dynamic balance with field trials, which together influence significantly the level of functional independence and that the study showed no threat of cardiovascular type responding to the indicator of heart rate remained at about acceptable ranges for age, gender and activity level.

In the case of speed the value presented by the sample of 9.39 ± 1.92 seconds is in line with the decline reported by several authors such as Doherty, Cuoco, and Sayers among others [8, 12, 20, 47, 48]. These studies reveal an association of values with neural damage (changes in the patterns of activation agonist / antagonist), structural (loss of muscle fibers *Fast Twich, FT)* and changes in body composition, which consequently impacts the ability to move the body in space in the shortest possible time.

Then, in a task as the speed-agility test that requires acceleration changes, the value of 12.93 ± 1.59 seconds reaffirms what Ramirez and et al presented [12], where low values are revealed in men and women by Korhonen et al [49], warning that the changes in running mechanics are associated with height and age or with the study of Grimby et al [50], which highlights the relationship of age with the cadence and the step length. In the case of dynamic equilibrium, the values of 21.97 ± 8.01 seconds are relatively lower to what was reported by Be-Long Cho et al [51], (24.1 ± 6.7) and Nelson et al [29], (24.1 ± 8.1) but slightly higher than presented in the study of Ramirez et al [13] (19.88 ± 7.73), which reveals a poor ability considering the frequency of physical activity sessions and their duration, especially when the compared times are extracted from sedentary samples.

Discussion related to the explosive force

Overall values for the height in *SJ* (12.23 ± 3.05 cm), *CMJ* (13.18 ± 3.04 cm) and *CMJas* (14.80 ± 4.01 cm) reflect a significant loss of explosive strength which has been documented in several studies as those of Gonzalez et al 2003 [45] (SJ = 12.69 ± 7.01, CMJ =13.90 ± 7,95) Ramirez et al [12, 13], with similar protocols, even with other laboratory and field procedures as described later also by Ramirez et al [20].

In the explanation of the phenomenon there are several studies that establish a multi-causal origin where they emphasize the evidence presented in relation to sarcopenia, the reduction of nervous activation, impairment of motor neurons (alpha), neuronal death, changes in electrochemical patterns (changes in neurotransmitters) and hormonal patterns (variations in the

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concentrations of testosterone, cortisol, growth hormone), among others (Frontera et al, Hurley et al, Grimby et al, Rice et al, Kraemer et al, Häkkinen et al , Pradhan et al, and Katzman et al [16, 17, 19, 50, 52-56], which revealed a significant effect on the expression of maximum and explosive strength with important consequences for the level of functional independence detected at two critical moments such as menopause or the onset of old age starting at the sixties.

General profile correlations with explosive strength and functionality tests

Both body mass index (BMI) and fat percentage have statistically significant relationships with explosive force. This inverse relationship shows a decrease in explosive force with increasing body weight and percentage of fat, findings that correlate well with changes in body composition of older adults and include not only tissue augmentation adipose [57], but a loss of muscle mass [58], both well-recognized effects on the health of the elderly [59].

Since it also was possible to demonstrate a relationship between the explosive strength and the proposed tests of function and independence of older persons, it is possible to link explosive strength to assessment models in this population as has been suggested in other studies [60].

Conclusion

In a situation as worrisome as the aging of our population and all the economic and social implications that this entails, the assessment of explosive strength, coupled with the body composition assessment provides us with tools readily available to contribute to the quantification of life quality and independence of our seniors, which allow us to set effective strategies when planning preventative strategies in public health.

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