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Historical Analysis of Participation in 161 km Ultramarathons in North America

Martin D. Hoffman, June C. Ong and Gary Wang

Participation trends in 100 m (161 km) ultramarathon running competitions in North America were examined from race results from 1977 through 2008. A total of 32,352 finishes accounted for by 9815 unique individuals were identified. The annual number of races and number of finishes increased exponentially over the study period. This growth in number of finishes occurred through a combination of (1) an increase in participation among runners ≥ 40 years of age from less than 40% of the finishes prior to the mid-1980s to 65–70% of the finishes since 1996, (2) a growth ($p < 0.0001$) in participation among women from virtually none in the late 1970s to nearly 20% since 2004, and (3) an increase in the average annual number of races completed by each individual to 1.3. While there has been considerable growth in participation, the 161 km ultramarathon continues to attract a relatively small number of participants compared with running races of shorter distances.

Analyse historique de la participation aux ultra-marathons de 161 km en Amérique du Nord.

Les tendances de la participation dans les ultra-marathons (161 km) en Amérique du Nord ont été examinées sur la base des résultats de course entre 1977 et 2008. Un total de 32 352 coureurs a terminé l'épreuve pour 9815 individus uniques identifiés. Le nombre d'épreuves et de coureurs ayant terminé leur course a augmenté chaque année de façon exponentielle au cours de la période d'étude. Cette croissance s'explique par la combinaison de : 1) une augmentation de la participation des coureurs de moins de 40 ans ou moins qui passent de moins de 40% de la totalité de

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ceux qui terminent la course au milieu des années 80 à 65–70% depuis 1996 ; 2) une croissance ($p < 0.0001$) de la participation des femmes qui passent de pratiquement zéro à la fin des années 1970 à près de 20 % depuis 2004 ; et 3) une augmentation à 1,3 du nombre annuel moyen de courses achevées par individu. Alors que l'augmentation de la participation a été considérable, l'ultra-marathon de 161 km continue à attirer un relativement faible de participants en comparaison de courses plus courtes.

Análisis histórico de la participación en ultramaratones de 161 kilómetros en Norteamérica

Se examinaron las tendencias en la participación en ultramaratones de 100 millas (161 kilómetros) en Norteamérica a partir de resultados de carreras entre 1977 y 2008. Se identificaron un total de 32.352 llegadas para 9.815 individuos participantes. El número anual de carreras y de llegadas creció exponencialmente durante el periodo estudiado. Este crecimiento en el número de llegadas se debe a una combinación de (1) un incremento en la participación de corredores de 40 años o más, desde menos de un 40% de las llegadas antes de mediados de los 80, a un 65–70% a partir de 1996, (2) un crecimiento ($p < 0.0001$) en la participación de mujeres desde casi ninguna a finales de los 70 hasta cerca del 20% a partir de 2004, y (3) un incremento en la media anual de carreras completadas por individuo hasta la cifra de 1,3. A pesar de que ha habido un considerable crecimiento de la participación, las ultramaratones de 161 kilómetros continúan atrayendo a un número relativamente pequeño de participantes comparadas con carreras de menor distancia.

Die Beteiligung an 161 km Ultramarathons in Nordamerika: eine historische Untersuchung

Die Trends in der Beteiligung an 100-Meilen (161 km) Ultramarathon Laufwettbewerben in Nordamerika wurden anhand von Resultaten der Jahre 1977 – 2008 analysiert. Eine Gesamtzahl von 32.352 Zieleinläufen von 9815 Einzelpersonen wurde untersucht. Die jährliche Anzahl von Rennen und Zieleinläufen stieg exponentiell innerhalb des analysierten Zeitraumes. Dieser Anstieg von Zieleinläufen kam zustande durch (1) einen Anstieg der teilnehmenden Läufer ≥ 40 Jahre von weniger als 40% der Zieleinläufe vor Mitte der 1980er bis hin zu 65–70% der Zieleinläufe seit 1996, (2) einen Anstieg ($p < 0.0001$) der Teilnahme von Frauen von buchstäblich keiner Teilnehmerin in den späten 1970ern bis zu annähernd 20% seit 2004 und (3) einen Anstieg der durchschnittlichen jährlichen Anzahl der beendeten Rennen jedes Einzelnen um 1,3. Neben dem nicht unerheblichen Anstieg der Teilnahme begeistert der 161 km Ultramarathon nach wie vor eine relativ kleine Anzahl von Teilnehmern verglichen mit Rennen kürzerer Distanzen.

对北美161公里超长距离马拉松运动参与情况的历史性分析

该文从1977年至2008年北美100英里(161公里)超长距离马拉松赛事的比赛结果,来研究参与者趋势。从32352名完成全程者中确定了9815个个案。年赛事量和完成者数量在研究期间都以指数方式增加。完成者在数量上的增长是通过以下的组合形式:(1)上世纪80年代中期以前,在年龄大于或等于40岁的运动员中,仅有不到40%的完成者,而从1996年以后,这一数字已达到65%至70%;(2)女性参与人数方面($p < 0.0001$),经历了从上世纪70年代后期“无人参赛”到自2004年来约有20%的女性运动员参与比赛的增长;(3)每名参赛者年平均参赛量的增长数为1.3个。尽管总体上参与超长距离马拉松运动的人数有较大幅度的增长,但是,与短距离赛跑的参与人数相比,161公里超长距离马拉松赛仍只吸引为数不多的参与者。

Participation in marathon distance (42.2 km) running events has increased substantially in recent decades. The estimated number of marathon finishes in the United States tripled between 1980 and 2007. [1] While the marathon represents the ultimate challenge for many individuals, ultramarathons (common distances of 50, 80, 100 and 161 km) have become the supreme test for an increasing number of athletes. Footraces of ultramarathon distances date back to the 1800's in the United States. [2] In fact, the professional runners of that era, commonly referred to as 'pedestrians', often took on multiple-day events. But, the popularity of participating in ultramarathon distance footraces in the United States was stimulated in the 1970's, largely from the advent of trail running competitions and the attraction of the 100 m (161 km) distance.

In 1974, a contestant in a horse race over mountain trails, on a course similar to the current 161 km Western States Endurance Run, decided to attempt the distance on foot because his horse had gone lame prior to the competition. [3] At the time, there were a few 161 km track and road races in the United States, but a footrace of this distance traversing mountain trails was unheard of. His successful completion of the event stimulated the development of an official running race over the same course in 1977, an event which quickly grew into an international competition. A second 161 km trail footrace was initiated in 1979, and by 2008 there were over 50 running races of this distance in North America, most of which were trail races.

While it is evident that there has been an increasing number of 161 km running events and growing participation in these events, the only analysis of trends in participation in such events is, as far as we are aware, our previous examination of the

Western States Endurance Run. [4] The present paper expands on that work to include all 161 km running events in North America. Specifically, we were interested in determining if certain subgroups, based on age and sex, have shown different participation trends compared with other subgroups.

Methods

This study was determined by our institution to be exempt from institutional review board approval since it involved the analysis of publicly available data.

Race results for 161 km running events in North America were collected from publicly available sources, including individual race websites, published results in *UltraRunning* magazine (beginning May 1981) and the *Ultradistance Summary* booklets of 1979 through 1985 and through direct contact with race directors. Results prior to 1980 were also supplemented by personal communication with race historians. In general, the data extracted included name, sex and age of the finishers, and name and year of the race.

Only events specifically stated to be continuous 100 mile (161 km) running competitions were included in the analysis. Staged (multiple-day) 161 km events were not included. Finishes from 161 km competitions that were associated with twenty-four hour runs were included in the analysis. It is recognized that some of the trail races were not an accurate 161 km in distance.

Name, age and sex discrepancies were reconciled to the extent possible through line-by-line examination of the data. Particular attention was directed towards identifying name changes through marriage or divorce, incorrect name spellings, and use of different given names. A calculated birth year, based on year of the event and recorded age at the time of the event, was used to assist identification of name discrepancies. Information about the state or country of origin of the runner, which was sometimes provided in race results, was also examined when there was uncertainty about whether given entries might represent different individuals. When an age datum was missing for a particular individual and event, age data from other events were used to calculate age. When the individual had not completed another 161 km event with age listing, other publicly available sources were used to assist with an age determination, including a race results website, [5] online postings of ultramarathon runner biographies, [6] and internet searches.

Linear regression analyses and non-linear curve fitting were used to examine data across time. Ages of men and women were compared with an unpaired *t*-test. To examine changes over time in the average annual number of races completed by each finisher, slopes were determined for the linear regressions of average annual number of finishes for each individual versus year among different subgroups. Comparisons among men and women within different age groups were then made with one-way ANOVA and Newman-Keuls post-hoc tests. Statistical significance was set at $p < 0.05$.

Results

Race results were obtained dating back to 1971 but, due to concern that the data were not adequately complete through much of the 1970s, results are presented starting in 1977. Across the time period of 1977 through 1982, we had no information (name, age, sex and finish time) for 45 finishes (5% of 907 known finishes over this time span), and lacked age data for another 32 finishes over this same time period. From 1983 through 2008, we believe our data to be complete with the exception of incomplete or missing altogether the results for 12 small races (of 589 total races during this time span) and missing age or sex data related to 181 finishes.

Figure 1 displays the number of 161 km ultramarathon races in North America for each year from 1977 through 2008. The number of events increased exponentially to a total of 53 in 2008. By far, the largest growth was in trail races which accounted for all but two of the events in 2008. Road and track events had an increased popularity during the early 1980's, but there was a decrease in these events during the later half of the decade.

The current and previous locations of 161 km ultramarathons in North America are shown in Figure 2. While races have been distributed across most of the United States, there are few races in Canada and none known to be in Mexico. The greatest concentration of races has been in California.

The frequency distribution across the months of the year for competitions that were scheduled for 2008 is shown in Figure 3. At least one race took place each month in 2008, with the greatest concentration being in August and September.

A total of 32,352 finishes were identified from 1977 through 2008. These finishes were accounted for by 9815 unique individuals (17.4% women and 82.6% men). The

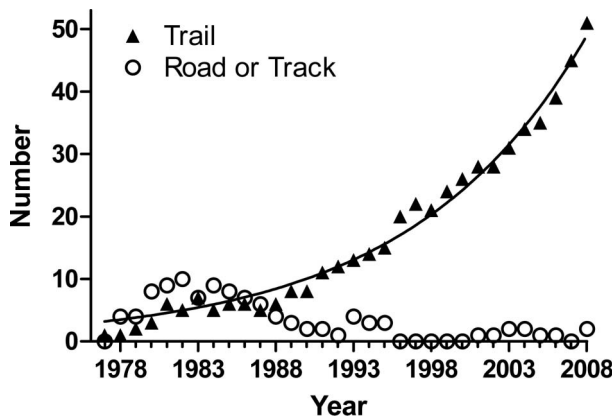


Figure 1. Number of 161 km trail races and road or track races in North America from 1977 through 2008. Exponential growth was seen among trail races ($r^2 = 0.99$, curve shown).



Figure 2. Location of 161 km running races in North America that were scheduled for 2008 (stars) and those that were held prior to 2008 (closed circles).

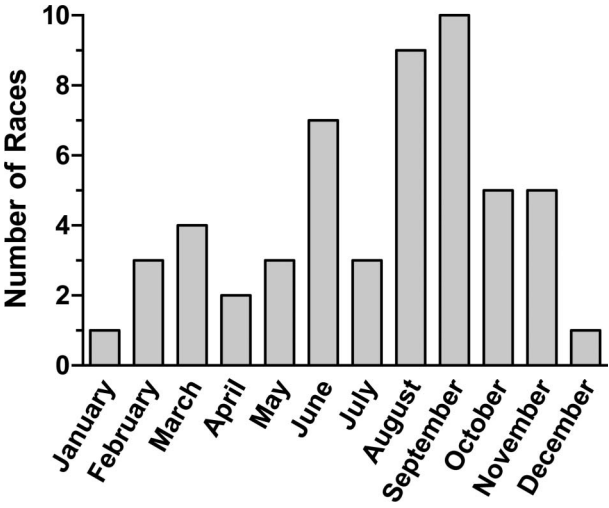


Figure 3. Frequency distribution of 161 km running races scheduled for 2008 across the months of the year.

annual total number of finishes, number of unique individuals who had finished and the number of individuals finishing a 161 km ultramarathon competition for the first time grew exponentially across the time period of 1977 through 2008 (Figure 4, top panel). Despite there being more road or track events than trail events through the first half of the 1980s, the number of finishes in road and track events remained smaller than that of trail races during this time period (Figure 4, bottom panel). Furthermore, the number of finishes in road and track events has remained small compared with that of trail races.

Participation among women increased ($p < 0.0001$) over the study period to the extent that women accounted for nearly 20% of the finishes by 2004 (Figure 5). The percentage of the unique individual finishers who were women also grew to around 20% by 2004.

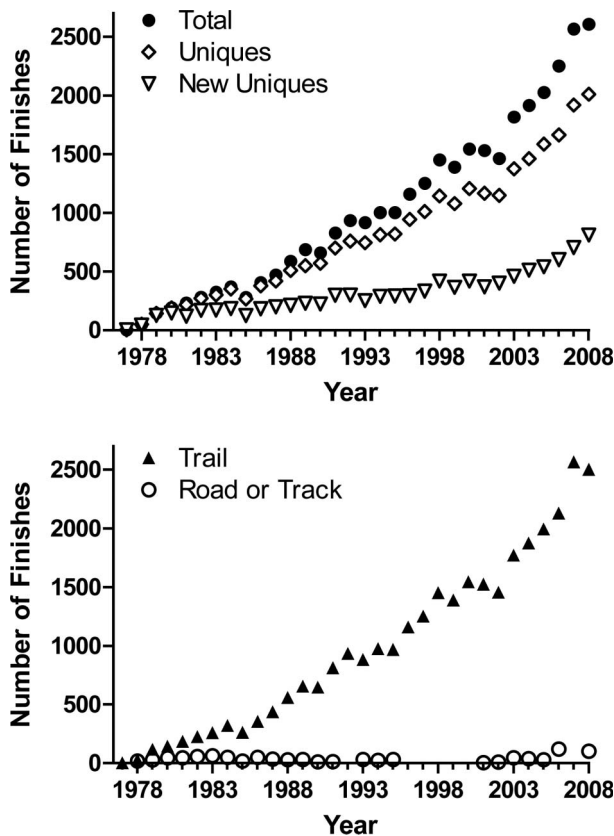


Figure 4. Total number of finishes, number of unique individuals finishing, and number of new unique individuals finishing (i.e. individuals with no prior finish) 161 km races across the study period (top panel) and number of finishes of trail events compared with road or track events (bottom panel). There was exponential growth in the total number of finishes ($r^2 = 0.98$), number of unique individuals finishing ($r^2 = 0.97$), number of new individuals finishing ($r^2 = 0.94$), and number of finishes of trail events ($r^2 = 0.97$).

Finishers ranged in age from 15–75 years for men and 18–75 years for women. The age distribution of finishers across the time span of 1977 through 2008 is displayed in Figure 6. Overall, women were significantly ($p < 0.0001$) younger than men (mean $\pm$ SD ages 41.1 ± 7.7 vs. 43.4 ± 9.2 years, respectively). The central quartiles spanned 37 to 50 years for men and 36 to 46 years for women. For the entire group, the central quartiles spanned from 37 to 49 years.

Mean ages of finishers generally increased ($p < 0.0001$) across time for both men and women following linear regressions of comparable ($p = 0.29$) slope (Figure 7). While mean ages decreased slightly for men from 2005 through 2008, the men remained older ($p = 0.037$) than the women in 2008 (mean $\pm$ SD ages 43.6 ± 9.8 and

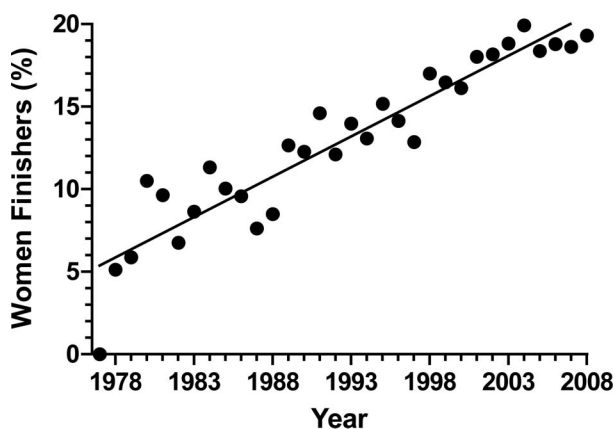


Figure 5. Percentage of finishes accounted for by women across the study years. The relationship was fit by the linear regression $y = 0.489x - 961$ ($r^2 = 0.87$, $p < 0.0001$).



Figure 6. Frequency distribution of ages for finishes accounted for by men (open circles) and women (closed circles) from 1977 through 2008.

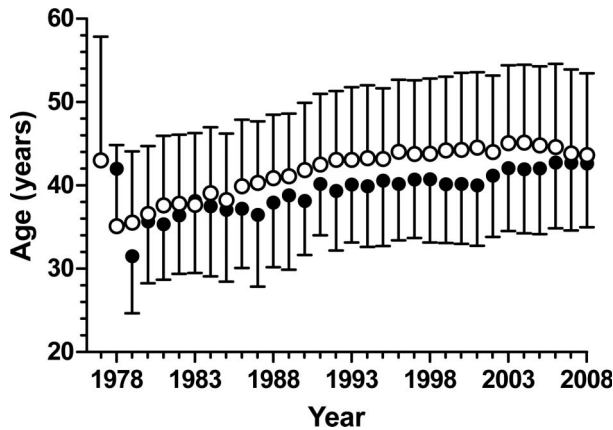


Figure 7. Mean ages of men (open circles) and women (closed circles) finishing 161 km runs across the time period of 1977 through 2008. Results are shown only for years in which there were at least 5 finishers with known ages for a given sex. Brackets represent 1 SD and are displayed in only one direction for clarity. Mean ages were described by the linear regressions $y = 0.276x - 508$ ($r^2 = 0.74$, $p < 0.0001$) and $y = 0.229x - 417$ ($r^2 = 0.65$, $p < 0.0001$) for men and women, respectively.

42.7 ± 7.7 years). The general increase in average age of finishers was largely accounted for by proportional increases among men ≥ 40 years of age, decreases among men < 40 years of age, and increases among 40–59 year old women (Figure 8).

The mean ($\pm$ SD) number of 161 km finishes by each individual across the time period of 1977 through 2008 was 3.3 ± 4.7 . The frequency distribution of number of finishes by each individual is shown in Figure 9. For both men and women, the largest group (47.6 and 48.8% of men and women finishers, respectively) had finished only a single race. A total of 687 individuals (7.0% of all unique finishers) had finished at least 10 races, and there were 153 runners (1.6% of all unique finishers) who had finished at least 20 races. The highest numbers of finishes by women were 60 and 71. The most number of finishes by a man was 102.

Given that the total number of annual finishes increased more than the number of unique individual finishers each year (Figure 4), there was an increase in the average annual number of 161 km races completed by each finisher to a value of around 1.3 by 2001. The trend of individuals completing an increasing number of 161 km races each year is evident from Figure 10 demonstrating not only the linear increase ($p < 0.0001$) in average annual number of races completed by each individual, but also a linear increase ($p < 0.0001$) in the maximum annual number of races completed by an individual. Remarkably, the maximum number of finishes by one person in a given year was 21.

This increase in average annual number of 161 km races completed by each finisher was further explored among different subgroups. Figure 11 shows the yearly

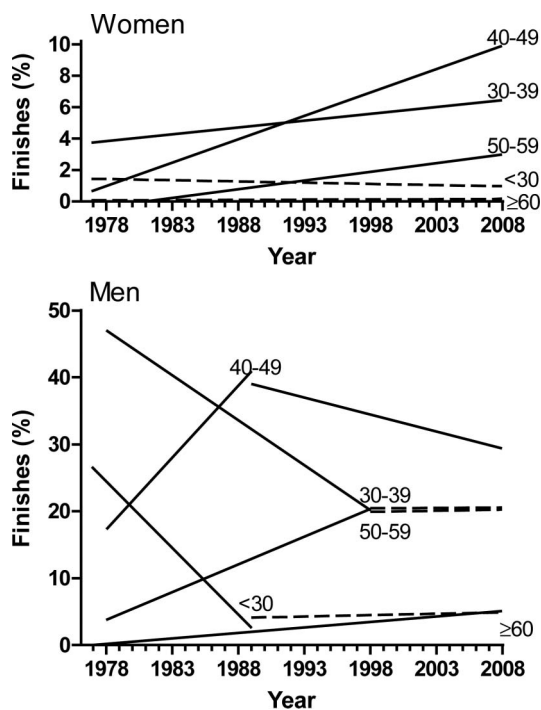


Figure 8. Percentage of finishers within different age groups across the study period for women (top panel) and men (bottom panel). Solid lines represent conditions where the slope of the linear regression was significantly different (each case $p \leq 0.002$) than zero. Dashed lines indicate the slope of the linear regression was not significantly different from zero. Across the time period of 1977 through 2008, the data for men within each age group except ≥ 60 years could not be well represented ($r^2 \leq 0.55$) by a single line or other standard curves. Splitting the study period allowed good ($r^2 = 0.84$ to 0.94) linear regression fits. Note the relative compression of the vertical axis for the men compared with that for the women.

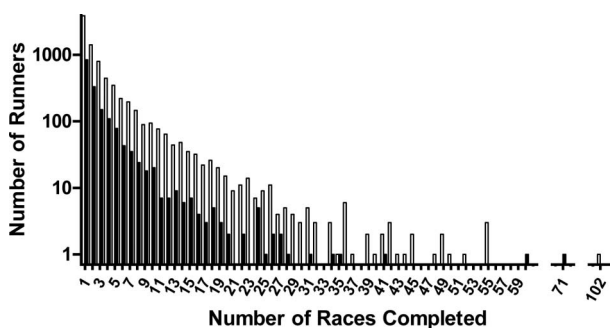


Figure 9. Histogram of number of 161 km races completed by individual men (open bars) and women (solid bars). Note the discontinuous horizontal axis and that the vertical axis is on a log scale.

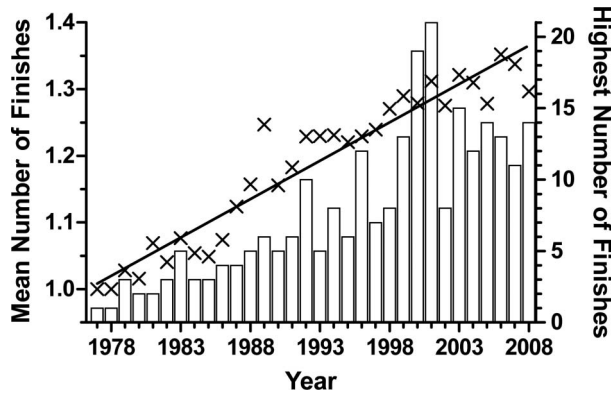


Figure 10. Mean annual number of finishes by each individual ($\times$) and linear regression (solid line). Bars represent the maximum annual number of races completed by an individual. The mean annual number of finishes by each individual increased ($r^2 = 0.92$, $p < 0.0001$) at a rate of 0.12 races per decade. The linear regression of the maximum annual number of finishes by an individual increased ($r^2 = 0.71$, $p < 0.0001$) at a rate of 4.7 races per decade (curve not shown).

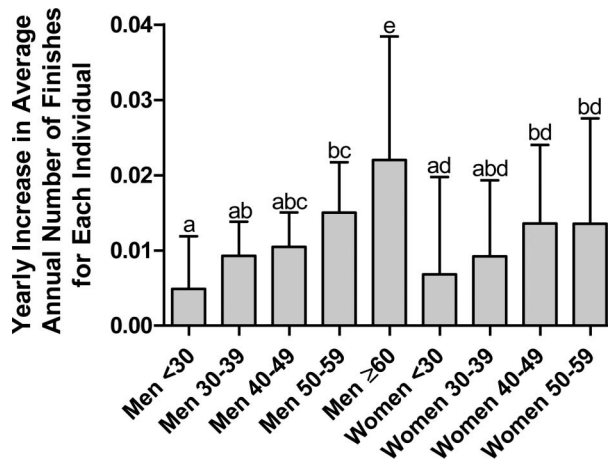


Figure 11. Yearly increases in average annual number of finishes for each finisher among men and women of different age groups. Values represent the slope for the linear regression of average annual number of finishes for each finisher with year. The slope was significant ($p \leq 0.007$) for each group except the ≥ 60 year old women, so data for this group are not displayed. Groups identified with the same letter were not significantly different from each other. Brackets represent 1 SD.

rate of increase in average annual number of finishes for each finisher among men and women within different age groups. These values represent the slope for each linear regression of average annual number of finishes for each individual with year.

Slope values were significantly different than zero ($p < 0.0001$) among all groups except the ≥ 60 year old women, so the figure does not include this group of women. In general, the ≥ 60 year old men had the greatest rate of increase in average annual number of finishes per individual, while the < 30 year old men and women had the least rate of increase. This translates to annual 161 km finishes of 1.56 and 1.17 per individual finisher, when averaged over the past 5 years, for the ≥ 60 year old men and the < 30 year old runners, respectively.

Discussion

Participation in 161 km ultramarathons has increased exponentially during the last three decades. The number of events of this distance has also increased across the United States, and has spread into Canada since 1996, to where there is currently at least one race of this distance every month somewhere in North America. This growth appears to have been due to greater appeal for trail races compared with road or track events. Despite a rather serendipitous beginning in the 1970s, 161 km trail races accounted for 51 of the 53 161 km ultramarathons in North America in 2008.

While participation in 161 km ultramarathons has dramatically increased, the number of people running races of this distance remains very low compared with runs of shorter distances. To place this in perspective, the total number of 161 km finishes in North America over the past 33 years ($\sim 32,000$) is considerably less than the number of finishers in a single New York City Marathon of recent years ($> 38,000$). [7] It's also worth noting that 161 km ultramarathons have remained relatively unique to North America since this distance has not been adopted as an international competition distance.

The growth in number of 161 km ultramarathon finishes was largely generated by an increase in participation among runners ≥ 40 years of age. Growth in participation among women, and an increase in the average annual number of races completed by each individual also accounted for some of the increase in number of finishes over the past three decades.

The age range of finishers of 161 km ultramarathons quite remarkably extended from 15 to 75 years, but half of the runners were between 37 and 49 years of age. Men averaged about 2 years older than the women. Interestingly, the average age of participants increased nearly 10 years since the late 1970s to 43–45 years where it remained during the past decade. This increase in average age was largely accounted for by an increase in the proportion of finishers ≥ 40 years of age. While runners ≥ 40 years of age typically accounted for less than 40% of the finishes prior to the mid-1980s, runners of this age consistently accounted for 65–70% of the finishes since 1996.

Considering trends in the age of participants, median ages of men and women finishing marathons increased from 34 and 31 years in 1980 to 40 and 36 years in 2007. [8] From 1983 through 1999, the greatest growth in participation in the

New York City Marathon was among ages 30–59 years for men and 20–49 years for women. [9] This indicates that the average age of marathon participants has been increasing at a similar rate to that of 161 km finishers and by the same mechanism, namely, through relatively greater participation among runners in the older age groups. Men have tended to be a little older than women in both events. Yet, across three decades, the 161 km run has continued to be an event that draws slightly older runners than the marathon with the average age of finishers being about 5 years older for the 161 km distance.

Accounting for virtually none of the finishes in the late 1970s, the growth in percentage of finishers who are women increased linearly to around 20% across the three decades examined. There has been considerable growth in participation by women in distance running races across the spectrum of distances. For instance, women accounted for 10.5% of finishers among all marathons in the United States in 1980 and 40% in 2007. [10] Likewise, among all road races in the United States, women accounted for 21% of the finishers in 1987 and over 49% in 2007. [11] Given that women currently account for nearly 20% of the 161 km finishes, participation by women in this distance remains relatively low compared with road races up to the marathon distance.

Another factor that accounted for the growth in number of 161 km finishes across the study period was an increase in average annual number of finishes by each finisher. In other words, the runners who participate in these events have been completing more of these races in recent years than in the past. Overall, the average annual number of finishes per individual runner has risen to around 1.3. Interestingly, men ≥ 60 year of age have shown the greatest increase in average annual finishes with this value rising to around 1.6 in recent years. Since the ≥ 60 year old men represent a relatively small percentage of the participants, their increase in average annual finishes made a limited impact on the overall number of finishes.

Over half of the 9815 individuals who had finished a 161 km ultramarathon over the time period of this study had completed more than one of these races. In fact, the average number of finishes per individual was 3.3. Yet, the number of individuals who had finished several of these races was reduced to a rather small group. For instance, less than 700 individuals had completed ten or more 161 km ultramarathons through 2008. On the other hand, there were a few individuals who had finished over 30 of these races, and one man who had a total of 102 finishes to his credit. Perhaps even more remarkable was the accomplishment by a woman of twenty-one 161 km ultramarathon finishes in a single year.

Even though there has been increasing levels of participation in 161 km ultramarathons in North America during the past 33 years, little has been written about the characteristics of these runners, trends in participation and performance, and factors that relate to competitive success. The main points to be taken from the present work are that over the past 33 years, there has been increasing participation among older runners, greater participation among women, and growth in the average

number of annual finishes for each individual finisher. While there has been considerable expansion of participation in 161 km ultramarathons, the event continues to attract a relatively small number of runners compared with shorter running races.

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Notes

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