THE RELATIVE AGE EFFECT IN THE TOP 100 ATP TENNIS PLAYERS 2016–2018

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ABSTRACT

The issue of the Relative Age Effect (RAE) has been monitored in the field of sports for more than 30 years. Its theoretical framework is based on the premise that during the pubescent period athletes born at the beginning of the year experience earlier biological acceleration resulting in a higher level of physiological, mental, morphological and psychological attributes than their later-born peers. A number of publications show that this temporary advantage often manifests itself in elite competitions at the junior level, but gradually disappears during the transition to professional senior competitions. The aim of this work was to determine the level of the RAE in the elite 100 ATP tennis players (ATP Rankings) in 2016–2018. To assess the influence of the RAE, the Chi-Squared (χ^2) test in the variant of Goodness of Fit was used for the assessment of the conformity of expected and observed frequency distribution due to the categorical character of the research data and the large sample size. The Cohen's *w* value calculation was used to assess the effect size (ES, since it is not a random representative selection of elements of the research set) of the χ^2 test values. The odds ratio (OR) was used to assess the chance of players from the Q_i individual quarters to get among the best 100 players. The results show that, in terms of effect size (ES), the effect of birth date in all the Top 100 players is small (*w* = .22) during the entire observed period 2016–2018; the influence of RAE is therefore dismissed. The ES in the individual years is again small (*w* = .21–.25); the influence of RAE is also dismissed. In analysing the effect of birth date, the mean rate of effect size was found in tennis players in positions 1 to 25 (*w* = .46) as well as in tennis players in positions 51 to 75 (*w* = .37); the RAE influence is therefore not rejected. Only a small measure of effect size was found between positions 26 to 50 and 76 to 100 (*w* = .21–.25); the RAE influence is rejected. No statistically significant difference has been found between the observed and expected distribution of birth date between the observed quarters of the year (odds ratio test, $p > .05$) and it has not, therefore, been proven that tennis players from any of the quarters Q_1–Q_4 had a better chance of getting among the Top 100 tennis players. It can be concluded that professional senior tennis had not shown the RAE influence to the extent usual in junior categories during the observed period of 2016–2018.

Keywords: biological acceleration; birth date; sports talent; professional; ATP Rankings

Introduction

In one of the oldest publications considering the influence of the Relative Age Effect (RAE) Green and Simmons (1962) found a significant difference between the study results attained by primary school pupils born at the beginning and at the end of the academic year, i.e. between relatively older and younger pupils in the same class. A difference between mental and chronological age was also demonstrated by the authors Jeronimus, Stavrakakis, Veenstra and Oldehinkel (2015). In one of the first publications considering the distribution of birth date in sport, Grondin, Deshaies and Nault (1984) confirmed the influence of birth date in hockey players (U11–U18, n=3,826), but not in volleyball players (n=1,391). The expression RAE – i.e. a larger chance of being selected among the elite group thanks to accelerated biological maturity – was first used in the area of sport in the study by Barnsley, Thompson and Barnsley (1985); a significantly greater representation of players born in the first half of the year (S_1 = 61.8–71.5 %) than of players born in the second half of the year (S_2 = 28.5–38.3 %) was found in a set of ice hockey players in two junior leagues (OHL, n=350; WHL, n=698) and one senior league (NHL, n=715) in Canada. Giacomini (1999) is apparently the author of the first publication considering the influence of RAE in tennis, in which he found a statistically significant difference in the frequency of tennis players born in the first half of the year as opposed to tennis players born in the second half of the year in the categories U14 and U16, though no difference was found in U18 boys or in girls (U14, U16, U18). Similar findings concerning the influence of RAE in tennis players (boys and girls) were also found by Filipcic (2001), who studied the Top 60 male and female Slovenian tennis players U12–U18 (n=460, national representation). A statistically significant influence of RAE was found in male tennis players U12–U16 (though not U18) and in female tennis players in the category U12–U14 (though not U16 or U18). The author ascribes the differences in the influence of RAE between boys and girls to the earlier completion of the biological development of girls. Although there are studies in which no statistically significant gender difference in the influence of RAE has been found (Agricola, Zháněl & Bozděch, 2017; Gutiérrez Aguilar, Saavedra García & Fernández Romero, 2017), a more pronounced influence of RAE is found in boys/men than in girls/women in the majority of the publications (Edgar & O'Donoghue, 2005; van den Honert, 2012; Werneck et al., 2016; Müller, Müller, Hildebrandt & Raschner, 2016). In spite of the fact that Edgar & O'Donoghue (2005) found a significant influence of birth date in Grand Slam participants in the years 2002–2003 (237 male, 211 female), recent studies more often come to the conclusion that the influence of RAE is demonstrable first and foremost in junior age categories and less frequently in senior categories, both in tennis and in other sports such as, for example, basketball (García, Aguilar, Galatti & Romero), handball (Sánchez-Rodríguez, Grande, Sampedro & Rivillagarcía, 2013) and football (van den Honert, 2012). The influence of RAE in tennis has been studied by, for example, Bozděch, Nykodým, Agricola and Zháněl (2017) at the World Junior Tennis Finals (WJTF) tournament in the years 2012–2016 (U14, boys, national representation, n=240), and they found a statistically significant influence of RAE. The predominance of tennis players born at the beginning of the year has also been confirmed by the study by Koloničný, Bozděch and Zháněl (2018) who monitored the influence of birth date in the Top 100 Czech junior tennis players (aged 10–12, n=1,500) in fourteen consecutive years (2003–2017). Pacharoni, Aoki, Costa, Moreira and Massa (2014) also found a significant influence of RAE at the junior level (U12–U18), though they did not demonstrate any influence of RAE in South American professional tennis players (ATP Rankings). The given conclusions are in agreement with the results of Agricola (2013) indicating that RAE has no influence on placement among the Top 100 tennis players according to the ATP rankings in 2011 (n=100). In junior age categories (U12–U18, n=128,454) Ulbricht, Fernandez-Fernandez, Mendez-Villanueva and Ferrauti (2015) found that the influence of RAE grows both with growth in performance level and with a higher age category in a large group of German tennis players. It is clear from the given synthesis of the knowledge that the issue of RAE is a widely and abundantly published topic, and not merely in tennis, for which reason we selected our research goal and formulated research questions within the scope of long-term research into the influence of RAE in tennis.

Methods

The aim of the research conducted was to determine whether the influence of RAE is demonstrable among elite professional tennis players who ranked in places 1–100 in the ATP Rankings in the years 2016–2018 (Top 100). We formulated the following research questions with a view to the synthesis of knowledge and the research goal:

1. Is it possible to demonstrate the influence of RAE in male professional tennis players in the individual years studied and in the entire studied period?
2. Can the influence of RAE be demonstrated in the placement of players in the individual quarters of the ATP rankings in the entire studied period?
3. Can the influence of RAE be demonstrated in the odds ratio of players to get among the 100 best tennis players (ATP Rankings)?

The research data was obtained from publicly accessible sources (https://www.atptour.com). The whole research set (n=300, male) was divided according to the research criteria (year of competition, year of birth, month of birth, ranking) and analysed by methods of descriptive (absolute and relative frequency) and inferential (Chi-Squared, Cohen's *w* and odds ratio test) statistics. The tennis players were assigned to the individual quarters on the basis of date of birth: Q_1 (January–March), Q_2 (April–June), Q_3 (July–September), Q_4 (October–December). To assess the influence of the RAE, the Chi-Squared (χ^2) test in the variant of Goodness of Fit was used for the assessment of the conformity of theoretical (expected, Qi = 25%) and empirical (observed) frequency distribution due to the categorical character of the research data and with a view to the large sample size (Albuquerque, Lage & da Costa, 2012; Müller, Hildebrandt, Schnitzer & Raschner, 2016). With a view to the intentional selection of elements of the research set, we assessed the material significance of the results (effect size, ES) by the Cohen's *w* and odds ratio (OR). The effect size (Cohen, 1988) can be expressed in word form as small (*w* = .10), medium (*w* = .30) or large (*w* = .50). To assess the odds of players getting among the 100 best tennis players (ATP Rankings TOP 100) from the individual quarters ($Q_{1–4}$) we used calculation of the odds ratio (OR) and the 95% confidence interval (CI). The odds ratio test compares the observed odds (research data) with the expected odds (population; Q_i = 25%). Assessment of the statistical significance of the results of the OR test was performed on the basis of the determined level of significance *p* (α = .05). The confidence interval (CI) then enables quantification of the uncertainty of measurement and shows the range of values in which 95% of the true value for the whole population is found (Cobley, Baker, Wattie & McKenna, 2009).

Results

The results of data analysis are presented in the results section according to the individual research questions.

The influence of RAE throughout the observation period and in individual years

The values of the χ^2 test and the effect size (Cohen's *w*), including verbal interpretation (ES), are presented in Table 1 in addition to an overview of the relative distribution of birth dates in individual quarters.

Table 1 *The influence of RAE in individual years and throughout the research period 2016–2018*

ATP	Birth quarters				*n*	χ^2	*p*	*w*	ES
	Q_1	Q_2	Q_3	Q_4					
2016	24.0%	35.0%	19.0%	22.0%	100	6.04	.11	.25	Small
2017	20.0%	35.0%	23.0%	22.0%	100	5.55	.14	.24	Small
2018	22.0%	33.0%	26.0%	19.0%	100	4.46	.22	.21	Small
2016–2018	22.0%	34.3%	22.7%	21.0%	300	14.41	.00	.22	Small

Note. Q_i = quarter; χ^2 = Chi-squared test; *p* = level of probability; *w* = Cohen's *w*; ES = effect size expressed in word form

While the distributions of the frequency of birth date in junior elite athletes in various sports often have a character that can be expressed as $Q_1 > Q_2 > Q_3 > Q_4$ (which expresses the possible influence of RAE), such a distribution of birth dates was not demonstrated in the set of elite professional tennis players we studied. It can be stated from the results given in Table 1 that, from the viewpoint of effect size (ES), the influence of RAE in individual years and throughout the research period is small (*w* = .21–.25, small) with a relatively large homogeneity of *w* values (diff = 0.04). Assessment of the influence of birth date (RAE) by means of statistical significance demonstrated that the effect of the influence of RAE cannot be rejected ($p < .01$) in the entire research period (2016–2018), which is influenced by the large size of the research set (n=300). The influence of birth date (RAE) in individual years is rejected from the viewpoint of statistical significance ($p > .05$). We can, therefore, state that, from the viewpoint of effect size and statistical significance (with the exception of the entire research period 2016–2018), no influence of RAE among elite tennis players (Top 100, ATP Rankings) was demonstrated either in the whole research period or in individual years.

The influence of the Relative Age Effect on ranking position

Table 2 contains an overview of the relative distributions of the birth dates of all tennis players in the research set (n=300) divided into quarters by placing in the ATP Rankings, as well as the values of the χ^2 test and effect size (Cohen's *w*), including its verbal interpretation (ES).

Table 2 *The influence of RAE on the ranking position of tennis players in the ATP rankings*

Ranking	Birth quarters				*n*	χ^2	*p*	*w*	ES
	Q_1	Q_2	Q_3	Q_4					
1–25	13.3%	42.7%	28.0%	16.0%	75	16.13	.00	.46	Medium
26–50	22.7%	29.3%	17.3%	30.7%	75	3.44	.33	.21	Small
51–75	17.4%	40.0%	25.3%	17.3%	75	10.32	.02	.37	Medium
76–100	34.7%	25.3%	20.0%	20.0%	75	4.71	.19	.25	Small

Note. see Table 1.

It can be seen from the results given in Table 2 that the largest influence of RAE was found in players in places 1–25 (*w* = .46; medium) and the smallest in tennis players in places 26–50 (*w* = .21; small). It can, then, be stated that from the viewpoint of effect size (ES) a medium influence of RAE was found in players in positions 1–25 and 51–75, while a small influence of RAE was demonstrated in players in positions 26–50 and 76–100. From the viewpoint of statistical significance, good agreement was shown between the observed and expected distribution of frequencies in players in positions 1–25 ($\chi^2 = 16.13$; $p < .01$) and 51–75 ($\chi^2 = 10.32$; $p < .05$), and the hypothesis on the influence of birth date cannot be rejected. We reject the hypothesis on the influence of RAE in tennis players who ended in positions 26–50 ($p > .05$) and 76–100 ($p > .05$).

Differences in the chance of placement among the Top 100 tennis players according to birth quarter

The overrepresentation of athletes born in Q_1 as compared to Q_4 is a frequent phenomenon in junior categories (particularly at a higher performance level), which means that athletes born at the beginning of the year have a greater chance of becoming professional athletes than individuals born in Q_4. The results of evaluation of these chances by means of calculation of the odds ratio test (OR) and 95% CI, which quantifies differences in the chance of placement in the ATP Rankings (Top 100) of tennis players born in various quarters, are given in Table 3.

Table 3 *The influence of RAE by different birth quarters*

ATP	Q_1:Q_2 (OR) [95% CI]	Q_1:Q_3 (OR) [95% CI]	Q_1:Q_4 (OR) [95% CI]	Q_2:Q_3 (OR) [95% CI]	Q_3:Q_4 (OR) [95% CI]
2016	0.66 [0.31, 1.41]	1.36 [0.61, 3.07]	1.26 [0.56, 2.86]	2.10 [0.95, 4.54]	0.80 [0.35, 1.82]
2017	0.55 [0.25, 1.21]	1.00 [0.43, 2.21]	1.00 [0.43, 2.24]	1.79 [0.83, 3.84]	1.01 [0.45, 2.23]
2018	0.64 [0.29, 1.39]	0.88 [0.40, 1.94]	1.16 [0.51, 2.65]	1.38 [0.65, 2.93]	1.32 [0.59, 2.95]

Note: CI = confidence interval; * = $p < .05$.

It is clear from Table 3 that tennis players born in Q_2 had a greater chance of a better placement in the ATP Rankings (Top 100) than tennis players born in Q_3 in each year. In contrast, tennis players born in Q_1 always had a smaller chance as opposed to tennis players born in Q_2. None of the OR values were, however, statistically significant ($p > .05$) and it cannot, therefore, be said that tennis players bon in a certain quarter have a significantly greater chance of getting among the best 100 tennis players (ATP Rankings) than tennis players born in another quarter.

Discussion

The results of our study demonstrate that the majority of male professional tennis players that ranked among the best 100 tennis players in the ATP Rankings in the years 2016–2018 were born in Q_2, though this finding is not in agreement with the results of studies concerning the influence of RAE in junior categories. The majority of these studies found a predominance of players born in Q_1 with a falling trend of the frequency of players born in the individual quarters up to Q_4 (Agricola et al., 2017; Bozděch et al., 2017; Koloničný et al., 2018; O'Donoghue, 2009; Ulbricht et al., 2015). As an example, we give the results of Bozděch et al. (2017) who studied the influence of RAE at the World Junior Tennis Finals (WJTF, male, n=240) in the years 2012–2016. The authors demonstrated the influence of RAE on the basis of assessment of the statistical significance of c^2 values in individual years and throughout the whole period ($p < .01$). Following calculation of the values of Cohen's w ($w = .58–.83$), this influence of RAE among junior players can also be considered significant also from the viewpoint of effect size (ES). With a view to the conclusions of the available studies, we therefore expected a significantly weaker influence of RAE in senior categories than in junior categories. It is true that Edgar and O'Donoghue (2005) found a statistically significant influence of RAE ($\chi^2 = 8.7$; $p = .03$) in players at senior Grand Slam tournaments (n=237, 2002–2003), though following calculation of the value of Cohen's w ($w = .21$) the influence of RAE from the viewpoint of ES must be considered small. The differing results of the assessment of the influence of RAE with the use of the effect size (more correct from the methodological perspective) and statistical significance are evidently affected by the relatively large size of the research set. In the case of the study by O'Donoghue (2009), who studied the influence of RAE among those taking part in Grand Slam tennis tournaments (n=193) in the years 2008–2009, the author showed a statistically insignificant

influence of RAE (χ^2 = 1.8; p = .61), which can also be considered insignificant following calculation of Cohen's w (w = .10). Loffing, Schorer & Cobley (2010) likewise did not demonstrate any influence of RAE on male professional tennis players ranked in the year-end ATP Top 500 for 2000–2006 (n=1,027; w = .17) and found a small influence of RAE in left-handed tennis players (n=138; w = .10) and right-handed tennis players (n=889; w = .19).

Similarly as in our study focusing on male professional tennis, a small influence of RAE (w < .30) has also been found in research into Olympic Taekwondo competitors (Albuquerque et al., 2012), the NHL, NBA, MLB and PGA (Cote, Macdonald, Baker & Abernethy, 2006), and French professional football, basketball, handball, volleyball, rugby and ice hockey players (Delorme, Boiché & Raspaud, 2009). The above conclusions confirm that the effect of the RAE is most evident during adolescence and is partially or not at all transferred to the senior (professional) categories. The reason for this phenomenon is that junior athletes often (unknowingly) take advantage of their relative age, which disappear after the end of adolescence. As a result, influence of the RAE is not so evident in the senior categories.

Although assessment of the odds of a successful tennis career by birth quarter showed the highest OR values in all studied years between Q_2:Q_3 (OR = 1.38–2.10), these values were statistically insignificant. In contrast, Müller, Gehmaier, Gonaus, Raschner and Müller (2018), for example, found that the largest association between variables is between Q_1:Q_4 (OR = 4.86) in young footballers (U9), which confirms the influence of RAE.

Conclusion

It was found during the analysis of research data (birth date) on elite professional tennis players that ranked among the Top 100 (positions 1–100) in the ATP Rankings in 2016–2018 that the influence of RAE was not demonstrated from the perspective of effect size (ES) or statistical significance in the individual years studied. The influence of RAE throughout the studied period was not demonstrated from the viewpoint of ES, but cannot be rejected from the viewpoint of statistical significance.

Assessment of the influence of RAE on the positioning of players in the individual quarters of the ATP rankings throughout the studied period demonstrated a medium influence of RAE in the seasons 2016–2018 among tennis players who ranked at the end of seasons (2016–2018) in positions 1–25 and 51–75, and just a small influence in players in positions 26–50 and 76–100.

Assessment of the influence of RAE on the chance of players getting among the 100 best tennis players (ATP Rankings) showed that no statistically significant association between expected and observed frequencies in individual quarters was found among male professional tennis players, and the influence of RAE was not, therefore, proven.

While a number of studies focusing on tennis have demonstrated the influence of RAE in junior categories, the results of our research have shown that its influence is not expressed in adulthood (in our case among Top 100 players in the ATP Rankings). Trainers, educators, parents and other experts working in sport for the young can be recommended to devote greater attention during the selection of sporting talent to the differences between the biological and chronological age of their charges and thereby help reduce the waste of possible sporting talent.

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References

Agricola A., Zháněl, J., & Bozděch, M. (2017). The comparison of the influence of the age effect between elite junior male and female tennis players. In M. Zvonař, & Z. Sajdlová (eds.). *The 11th International Conference on Kinanthropology.* 313–321.

Agricola, A. (2013). *Vplyv age effect v tenise* (Dissertation paper). Retrieve from https://theses.cz/id/2ntau5/Adrian_Agricola_Age_Effect_v_tenise_Diz__praca.pdf

Albuquerque, M. R., Lage, G. M., & Da Costa V. T. (2012). Relative age effect in olympic taekwondo athletes. *Perceptual and Motor Skills, 114(*2), 461–468.

Barnsley, R., Thompson, A., & Barnsley, P. (1985). Hockey success and birthdate: the relative age effect. *Cahper Journal, 51*(8)*,* 23–28.

Bozděch, M., Nykodým, J., Agricola A., & Zháněl, J. (2017). The relative age effect in the world junior tennis finals 2012-2016 (male). In M. Zvonař, & Z. Sajdlová (eds.). T*he 11th International Conference on Kinanthropology.* 322–330.

Cobley, S., Baker, J., Wattie, N., & McKenna, J. (2009). Annual Age-Grouping and Athlete Development A Meta-Analytical Review of Relative Age Effects in Sport. *Sports medicine*, *39*(3), 235–256.

Cohen, J. (1988). *Statistical power analysis for the behavioural sciences* (2nd ed). Hove, England: Lawrence Erlbaum Associates.

Cote, J., Macdonald, D. J., Baker, J., & Abernethy, B. (2006). When “where” is more important than ”when”: Birthplace and birthdate effects on the achievement of sporting expertise. *Journal of sports sciences*, *24*(10), 1065–1073. doi: 10.1080/02640410500432490

Delorme, N., Boiché, J., & Raspaud, M., (2009). The Relative Age Effect in Elite Sport, *Research quarterly for exercise and Sport, 80*(2), 336–344. doi: 10.1080/02701367.2009.10599568

Edgar, S., & O’Donoghue, P. (2005). Season of birth distribution of elite tennis players. *Journal of Sports Sciences, 23*(10)*,* 1013–1020.

Filipcic, A. (2001). Birth date and success in tennis. *ITF coaching & sport science Rview,* 9(23), 9–11.

Giacomini, G. P. (1999). Association of birthdate with success of nationally ranked junior tennis players in the united states. *Perceptzral and Motor Skills*, *89*(2), 381–386.

Green, D. R., & Simmons, S. V. (1962). Chronological age and school entrance. *The Elementary School Journal, 63*(1)*,* 41–47.

Grondin, S., Deshaies, P., & Nault, L. (1984). Trimestres de naissance et participation au hockey et au volleyball. *La Revue Québécoise de l’Activité Physique*, *2*(3), 97–103. doi: hdl.handle.net/20.500.11794/373

Gutiérrez Aguilar, O., Saavedra García, M., & Fernández Romero, J. J. (2017). Constituent year effect in international handball at high level. *Journal of Human Sport and Exercise, 12*(2), 316–324. doi:10.14198/jhse.2017.122.08

Jeronimus, B. F., Stavrakakis, N., Veenstra, R., & Oldehinkel, A. J. (2015). Relative Age Effects in Dutch Adolescents: Concurrent and Prospective Analyses. *Plos One, 10*(6)*,* 1–17. doi: 10.1371/journal.pone.0128856

Koloničný, R., Bozděch, M., & Zháněl, J. (2018). Longitudinal study of the influence of the relative age effect (rae) on Czech tennis players aged 10–12. *Studia sportiva, 12(*1), 125–131.

Loffing, F., Schorer, J., & Cobley, S. P. (2010). Relative Age Effects are a developmental problem in tennis: but not necessarily when you're left-handed!. *High ability studies, 2*1(1), 19–25. doi:10.1080 /13598139.2010.488084

Müller, L., Gehmaier, J., Gonaus, Ch., Raschner, Ch., & Müller, E. (2018). Maturity Status Strongly Influences the Relative Age Effect in International Elite Under-9 Soccer. *Journal of Sports Science and Medicine, 17*(2), 216–222

Müller, L., Hildebrandt, C., Schnitzer, M., & Raschner, C. (2016). The Role of a Relative Age Effect in the 12th Winter European Youth Olympic Festival in 2015. *Perceptual and Motor Skills*, *122*(2), 701–718. doi:10.1177/0031512516640390

Müller, L., Müller, E., Hildebrandt, C., & Raschner, C. (2016). Biological Maturity Status Strongly Intensifies the Relative Age Effect in Alpine Ski Racing. *Plos One*, *11*(8), e0160969. doi: 10.1371/ journal.pone.0160969

O'Donoghue, P. (2009). Relative Age in elite tennis*. Studies in Physical Culture & Tourism, 16*(4), 379–388.

Pacharoni, R., Aoki, M. S., Costa, E. C., Moreira, A., & Massa, M. (2014). Efeito da idade relativa no Tênis. *Revista Brasileira De Ciência E Movimento, 22*(3)*,* 111–117.

Sánchez-Rodríguez, C., Grande, I., Sampedro, J., & Rivillagarcía, J. (2013). Is the date of birth an advantage/ally to excel in handball?. *Journal of Human Sport & Exercise*, *8*(3), 754–760. doi: 10.4100/jhse.2013.8.Proc3.22

Ulbricht, A., Fernandez-Fernandez, J., Mendez-Villanueva, A., & Ferrauti, A. (2015). The Relative Age Effect and Physical Fitness Characteristics in German Male Tennis Players. *Journal of Sports Science & Medicine, 14*(3)*,* 634–642.

Van den Honert, R. (2012). Evidence of the relative age effect in football in Australia. *Journal of Sports Sciences*, *30*(13), 1365–1374. doi: 10.1080/02640414.2012.707329

Werneck, F., Coelho, E., de Oliveira, H., Ribeiro Júnior, D., Almas, S., de Lima, J., ... Figueiredo, A. (2016). Relative age effect in Olympic basketball athletes. *Science & Sports*, *31*(3)*,*158–161. doi: 10.1016/j.scispo.2015.08.004