A longitudinal investigation into the relative age effect in an English professional football club: Exploring the 'underdog hypothesis'

Adam L. Kelly[1,2,3], Mark R. Wilson[2,3], Lewis A. Gough[1], Harry Knapman[3], Paul Morgan[2,3,4], Matthew Cole[1], Daniel T. Jackson[1], and Craig A. Williams[2]

[1]Faculty of Health, Education and Life Sciences, Birmingham City University, Birmingham, West Midlands, United Kingdom; [2]College of Life & Environmental Sciences, University of Exeter, Exeter, Devon, United Kingdom; [3]Exeter City Football Club, Exeter, Devon, United Kingdom; [4]College of Life & Environmental Sciences, University of Birmingham, Birmingham, West Midlands, United Kingdom

Correspondence: A. L. Kelly, Department of Sport & Exercise, Birmingham City University, City South Campus, Westbourne Road, Edgbaston, B15 3TN, UK. E-mail: Adam.Kelly@bcu.ac.uk

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The relative age effect (RAE) refers to the bias influence of birthdate distribution, with athletes born later in the selection year being under-represented in talent development systems. However, despite their recruitment constraints at youth level, the 'underdog hypothesis' (UH) has shown that younger birth quarter (BQ) athletes are over-represented among those who successfully transition from youth systems to senior professional status. Accordingly, the purpose of this study was twofold; 1) to provide further test of the RAE over twelve seasons (n=556), and 2) to examine the BQ of professional contracts awarded to academy graduates at an English professional football club over eleven seasons (n=364). Significantly skewed (P<0.001) birthdate distributions were found for academy players (BQ1 n=224: BQ2 n=168; BQ3 n=88; BQ4 n=76). The distribution from academy graduates was also significantly skewed for professional contracts awarded (P=0.03), with greater BQ4 representation (n=8) compared to other BQs (BQ1 n=5; BQ2 n=8; BQ3 n=6). These findings suggest that the RAE continues to manifest within an academy setting. Interestingly however, the UH shows BQ4s were approximately four times more likely to achieve senior professional status compared to BQ1s. Implications for talent identification and development in football are discussed.

Keywords: Relative age effect; Underdog hypothesis; Youth football academy; Youth soccer; Talent identification; Talent development

Introduction

The aim of a football academy is to recruit young players with the potential to be developed into professional football players, in order to achieve both sporting and financial success (Gonaus & Muller, 2012). It is therefore important to identify early predictors of long-term success so that the most highly talented youth football players receive continued support from a young age to achieve their potential (Stratton, Reilly, Williams, & Richardson, 2004). However, the complex nature of the talent development process, coupled with the holistic characteristics that are associated with superior development and the successful transition from youth academy level to senior professional status, suggests that the application of the early predictors is often flawed and subject to biases which limits academies' success in meeting their stated aims (Forsman, Blomqvist, Davids, Liukkonen, & Konttinen, 2016; Kelly, Wilson, & Williams, 2018; Sarmento, Anguera, Pereira, & Araujo, 2018).

One such bias is the influence of selection and progression through birthdate distribution; known as the relative age effect (RAE) (Barnsley, Thompson, & Barnsley, 1985). The RAE signifies that children born in the first six months of the selection year are significantly over-represented in youth team selection (Helsen, van Winckel, & Williams, 2012). Research has consistently shown that young athletes who are born early in the selection year have a distinct advantage through being older, bigger, faster, stronger, and more mature, thus are more likely to be perceived as 'talented' and subsequently selected for talent development programmes (Baxter-Jones, 1995; Gil et al., 2014; Gil, Ruiz, Irazusta, Gil, & Irazusta, 2007; Musch & Grondin, 2001; Wattie, Schorer, & Baker, 2015). The RAE is almost ubiquitous in youth sport, having been demonstrated in athletics (Hollings, Hume, & Hopkins, 2014), Australian rules football (van Der Honert, 2012), baseball (Grondin & Koren, 2000; Nakata & Sakamoto, 2013), basketball (Delorme & Raspaud, 2009), cricket (Edwards, 1994; McCarthy, Collins, & Court, 2016), dance (van Rossum, 2006), ice hockey (Nolan & Howell, 2010; Turnnidge, Hancock, & Cote, 2014), rugby league (Till et al., 2010), rugby union (McCarthy & Collins, 2014; McCarthy et al., 2016), swimming (Cobley et al., 2018), and tennis (Dudink, 1994; Ulbricht, Fernandez-Fernandez, Mendez-Villanueva, & Ferrauti, 2015) (amongst others).

In 'elite' youth football specifically, birthdate distribution also has a significant impact on player identification and development (Barnsley, Thompson, & Legault, 1992; Glamser & Vincent, 2004; Gonzalez Bertomeu, 2018; Gonzalez-Villora, Pastor-Vicedo, Cordente, 2015; Helsen et al., 2012; Helsen, Hodges, van Winckel, & Starkes, 2000; Helsen, van Winckel, & Williams, 2005; Massa et al., 2014; Meylan, Cronin, Oliver, & Hughes, 2010; Musch & Hay, 1999; Padron-Cabo, Rey, Luis Garcia-Soidan, & Penedo-Jamardo, 2016; Votteler & Honer, 2014, 2017; Williams, 2010). For example, in a Europe-wide study, Helsen et al. (2005) found an over-representation of players born in the first birth quarter (BQ) in both national and professional youth selections across all age groups (cf. Doyle & Bottomley, 2018; Gonzalez-Villora et al., 2015). In Brazil, Massa et al. (2014) found a similar effect in a single professional football club. In fact, a strong RAE in youth football has been established in America, Australia, Brazil, Germany, and Japan (amongst others), suggestive of a consistent global effect that is independent of the specific cut-off dates used to define the sporting year across countries (Votteler & Honer, 2014, 2017; Glamser & Vincent, 2004; Musch & Hay, 1999).

These research studies highlight the limitations of the selection process within youth football, which restrict the opportunities for players born late in the sporting year (Meylan et al., 2010). The potential cost of missing this talent may be hard to calculate accurately, but what can be investigated is the degree to which late BQ players who do make it into an academy make the successful transition into senior professional football. McCarthy and Collins (2014) discovered that late-birth players actually achieved more senior professional contracts compared to their older peers in a major English rugby union academy, subsequently suggesting this may be due to the relatively younger players developing superior psychological skills and technical expertise to compensate for their early physical disadvantage. This has been further supported in professional cricket (McCarthy et al., 2016), professional ice hockey (Gibbs, Jarvis, & Dufur; 2012; Fumarco, Gibbs, Jarvis, & Rossi, 2017), and professional rugby league (Till, Cobley, Morley, O'Hara, Chapman, & Cooke, 2016). For instance, Till et al. (2016) highlighted how relative age influenced the percentage of rugby league academy players attaining professional status, with chronologically younger players achieving a greater total (BQ2 = 8.5% versus BQ4 = 25.5%). In professional ice hockey, Fumarco et al. (2017) reported that players born in BQ4 score more and demand higher salaries compared to those born in BQ1, whilst Gibbs et al. (2012) have also revealed that the average career duration is longer for players born later in the selection year. Gibbs et al. (2012) further proposed an 'underdog hypothesis' (UH), whereby being a younger BQ essentially facilitates long-term development by necessitating them to overcome the odds of the RAE, through being challenged by their older and more advanced peers.

From a football perspective, whilst the RAE has been extensively examined, research often focuses on the older age groups within 'youth' settings (i.e., under-19) at top European clubs or countries (cf. Doyle & Bottomley, 2018; Gonzalez-Villora et al., 2015; Padron-Cabo et al., 2016). However, it is important to appreciate that professional status can be achieved at lower league levels, whilst the recruitment of BQs throughout the development process (i.e., under-9 to under-18) must also be considered to examine the extent to which the RAE is rooted. The status of professional football academies must also be acknowledged whilst examining the RAE, as external validity from the existing research that often captures higher category standings may be questioned for lower category equivalents. For instance, differences in BQ recruitment may be apparent as a result of greater monetary outlay and the subsequent access and opportunities that are provided to young players.

It is evident that there is a complicated relationship between the BQ a player is born in, their opportunities to be selected into a talent development programme, and their chances of successfully transitioning from such a programme. To the authors' knowledge, there are no studies that have investigated the UH within a Category 3 academy and Tier 4 English professional football club. Therefore, the aim of this study was twofold; 1) to examine the RAE in a Category 3 academy, and 2) to test the UH by examining the BQ of academy graduates and the subsequent professional contracts awarded at a Tier 4 English professional football club.

Methods

Participants

For Part 1, to examine the existence of the RAE, 556 participants were included who were either current or previously registered academy players. The oldest players were born in 1989 and the youngest born in 2008, which includes data across twelve seasons. For Part 2, to examine the possibility of the UH, 364 participants were included who were previously registered academy players, to assess which graduates achieved a senior professional contract at aged 18 years across eleven seasons, with the oldest academy alumni born in 1989 and the youngest born in 1999. All the participants were recruited from the same Tier 4 English professional football club and their Category 3 academy. This study was approved by the Ethics Committee of Sport and Health Sciences at the University of Exeter.

Procedure

The twelve months of the year were divided into four BQs, conforming to the strategy used to examine the RAE in other UK populated studies (Helsen et al., 2005), with September classified as 'month 1' and August 'month 12'. To conform with previous studies of a similar design (cf. McCarthy et al., 2016; McCarthy & Collins, 2014; Till et al., 2010), each player was assigned a BQ in their selection year, which were compared to the expected distributions from the calculated average national live births in England and Wales (Office for National Statistics [ONS], 2015). For Part 2, as each player had graduated from the academy, the data collection also examined who achieved senior professional status; defined as signing a full-time professional contract for a minimum of one year. In addition to comparing the contracts awarded distributions to the ONS (2015) expected distributions, they were also compared against the academy distributions to gain a full understanding of any bias effects.

Data analysis

Chi-square (χ^2) analysis was used to compare quartile distributions in the sample and against population values (ONS, 2015), through following procedures outlined by McHugh (2013). As this test does not reveal the magnitude of difference between quartile distributions for significant chi-square outputs, Cramer's V was also used. The Cramer's V was interpreted as per conventional thresholds for correlation; a value of 0.06 or more would indicate a small effect size, 0.17 or more would indicate a medium effect size, and 0.29 or more would indicate a large effect size (Cohen, 1988). Odds Ratios and 95% confidence intervals were used to compare BQs for achievement of academy and professional status. For all the tests, results were considered statistically significant when $P < 0.05$. Data are presented as mean ± SD unless otherwise indicated. All statistical analyses were conducted using IBM SPSS Statistics Version 24.

Results

The academy quartile distributions were significantly skewed with a large effect size compared to national norms ($\chi2$ (df = 3) = 103.57, $P < 0.001$, V = 0.305). Significant ORs were found between BQ1 and BQ3 (OR: 2.46, 95% CI 1.73–3.46), BQ1 and BQ4 (OR: 2.94, 95% CI 2.08–

4.17), and BQ2 and BQ3 (OR: 1.92, 95% CI 1.36–2.73), and BQ2 and BQ4 (OR: 2.30, 95% CI 1.60–3.29). Thus, both BQ1 and BQ2 were more likely to be an academy player than those with BQ3 or BQ4 age. Descriptive statistics demonstrate BQ1s (n = 224, 40.29%) were over-represented compared to any other BQ (BQ2 n = 168, 30.22%; BQ3 n = 88, 15.83%; BQ4 n = 76, 13.66%). The academy data is presented in Figure 1.

****Figure 1 near here****

When examining contracts awarded, the quartile distribution was not skewed compared to national norms ($\chi 2$ (df = 3) = 1.06, P = 0.709, V = 0.08). Interestingly however, BQ4s represented a larger portion of professional contracts awarded for academy graduates (n = 8, 14.0%) compared to the other BQs (BQ1 n = 5, 3.5%; BQ2 n = 8, 7.4%; BQ3 n = 6, 11.1%). Figure 2 presents the percentage of professional contracts awarded within each BQ based on the total number of academy graduates within each BQ.

****Figure 2 near here****

Whilst further examining contracts awarded, the quartile distributions were significantly skewed with a large effect size when compared to the academy distributions ($\chi 2$ (df = 3) = 8.91, P = 0.03, V = 0.41). The only significant OR was found between BQ1 and BQ4 players, with BQ4 more likely to attain professional status (OR: 4.72, 95% CI 1.50–14.85). This is also highlighted in the almost twice as many observed (BQ4 n = 8) than expected (BQ4 n = 4.23) contracts awarded. Figure 3 presents the total number of observed and expected professional contracts awarded in each BQ. The descriptive statistics are also presented in Table 1.

****Figure 3 near here****

****Table 1 near here****

Discussion

Football academies are the primary talent development system for professional football in England. The decisions made with regards to who is selected into these systems at an early age constrains the subsequent outputs from that system. Therefore, it is important to better understand why certain individuals might be more likely to enter an academy, and also why others might be more likely to successfully graduate. The current study sought not only to provide further evidence of the RAE (a bias in early selection) within a Category 3 academy, but to also provide an examination of the UH (a potential bias in late graduation) within a Tier 4 professional football club in England.

The results from Part 1 of this current study are consistent with similar RAE research within elite youth football (Gonzalez-Villora et al., 2015; Helsen et al., 2005; Massa et al., 2014; Williams, 2010). For instance, the distribution of BQ percentages are similar to those of Takacs and Romann (2016), who found a significant RAE and medium effect size amongst UEFA Youth League clubs, illustrating that BQ1s were 3.4 times more likely to be selected compared to BQ4s. This study comparably found BQ1s were 2.9 times more likely to be selected compared to BQ4s. Similarly, the BQ distributions of this current study are equivocal to those from Massa et al. (2014), whose observational case study of the famed Sao Paulo Football Club presented a 47.5% BQ1 distribution compared to an 8.8% BQ4 distribution within their academy. Subsequently, this study does not only provide further evidence that the RAE exists across countries and is independent of selection cut-off dates, it also offers a unique interpretation that the RAE may be a deep-rooted phenomenon throughout the academy pathway (under-9 to under-18) and is equally apparent at lower category status when compared to their higher category counterparts. Therefore, despite over 25 years of research highlighting this birthdate advantage (Barnsley et al., 1992), the RAE appears to continue to manifest within elite youth football (cf. Helsen et al., 2012).

The predictions for Part 2 of the study were also supported, with BQ4 players approximately four times more likely to achieve a professional contract compared to BQ1 players. As per Figure 3, when comparing the observed and expected professional contracts awarded, there appears to be a form of RAE reversal; similar to that observed by McCarthy et al. (2014; 2016). BQ4s achieved almost double the number of expected professional contracts when inspected against retrospective academy distributions. This is in contrast to the BQ1s, who achieved less than half of their expected number of professional contracts. This may suggest a reversal of the distribution bias in the youth to senior transition, indicative of the potential advantage to those chronologically younger players within an English football academy.

A number of previous studies that have identified a RAE within a youth football setting have criticised its existence, and supported the need for interventions to eliminate such observed effects (Gonzalez-Villora et al., 2015; Helsen et al., 2012, 2005; Massa et al., 2014). For example, Massa et al. (2014) stated the existence of the RAE needs to be considered during the identification and development of young football players and should be analysed carefully in order to minimise the loss of potential talent. Gonzalez-Villora et al. (2015) further suggest the football federations of different countries should take responsibility for the RAE, and thus adapt the rules of youth competitions for the best development of all players on equal terms.

Despite these calls, there have been few research studies examining modifications to the talent development process. With regards to group bandings to combat physical discrepancies, Vandendriessche et al. (2012) demonstrated how the Royal Belgian Football Association installed, alongside their normal national youth teams (under-16 and under-17), two future national teams comprising of on-time and late maturing players (under-16 Futures and under-17 Futures), which highlights the benefits of avoiding a one-dimensional chronological approach. Further strategies to support the development of younger and less mature players includes the incorporation of banding players based on their biological age, compared to the fixed chronological age groupings that are commonly employed (Cumming, Lloyd, Oliver, Eisenmann, & Malina, 2017). This grouping approach, commonly known as 'bio-banding', clusters players based on their percentage of predicted adult height attained, thus moderating growth and maturation biases that can impact upon an individual's relative age (Cumming et al., 2018a, 2017; Muller, Gehmaier, Gonaus, Raschner, & Muller, 2018). Subsequently, it is suggested that future research explores further group banding strategies to moderate the RAE, to avoid a fixed chronological age grouping policy that is bias towards older players.

However, perhaps a cultural change is also required in talent identification. Professional football clubs in England can begin to formally sign academy players at under-9, and 'talent' at this early stage tends to be identified as current ability in comparison to peers, leaving little thought surrounding the characteristics that support the subsequent achievement of expertise as a senior athlete (MacNamara & Collins, 2011). As these players will form the core of each successive age group for the proceeding years, biases in selection into an academy (i.e., the RAE) will subsequently manifest over a prolonged period. Therefore, since the purpose of an academy should be to identify and then develop young football players towards future performance abilities, attention should rather concentrate on those characteristics to manage the course of development, rather than focussing on current performance abilities (Abbott & Collins, 2004). Mann and van Ginneken (2017) have produced evidence for an intervention designed to reduce the RAE through applying an age-ordered shirt numbering system. They found that supporting talent scouts with the knowledge that the numbers on the playing shirts corresponded with the relative age of the players eliminated age bias. Future research should further explore the implications of this, and other strategies, on the biases of talent scouts and the future enablement of earlier BQ players.

One interesting issue raised by the Part 2 results of this current study is that eliminating the RAE in academy football may also remove the potential 'underdog' benefits for BQ3 and BQ4s, through engaging with their older, more mature BQ1 and BQ2 peers. For example, it has been suggested that through playing against relatively older, more mature athletes within their chronological age group, BQ3 and BQ4s have to develop certain technical proficiencies and/or tactical awareness to be able to counteract this physical bias (Fumarco et al., 2017; Gibbs et al., 2012; McCarthy & Collins, 2014; McCarthy et al., 2016; Schorer, Cobley, Busch, Brautigam, & Baker, 2009). From an applied perspective, a larger, stronger player may be able to easily dispossess a smaller, weaker opponent as a result of their physical dominance, thus a smaller, weaker player must create a technical or tactical solution to reduce this advantage. Ashworth and Heyndels (2007) highlight how these younger, smaller players must overcome 'a system that discriminates against them', through being more talented than their relatively larger counterparts to counteract their size advantage. Therefore, it may be suggested that BQ3 and BQ4s are likely to be 'positively' selected, whereby they are chosen from 'the right tail of the ability distribution' (Fumarco et al., 2017).

Furthermore, while a smaller, weaker player may be physically inferior throughout their youth development as a result of their younger age, once they 'catch-up' towards adulthood, they may have developed certain psychological characteristics that previously allowed them to compete (Gonzalez Bertomeu, 2018). For example, Schorer et al. (2009) also demonstrated the UH, where the initial disadvantage may eventually contribute to the later superiority when early differences in size plateau towards adulthood. This is potentially through learning to 'work harder', resulting in peer effects that facilitate resilience and improved motivation (Schorer et al., 2009). Thus, these psychological benefits likely equip the chronologically younger players, or 'underdogs', to overcome subsequent obstacles and succeed at senior professional level (Fumarco et al., 2017; Roberts & Stott, 2015). Cumming et al. (2018b) provided further partial support for the UH, whereby relatively younger players benefitted from competitive play with older peers, whilst identifying later maturing players possessed a psychological advantage compared to their earlier maturing equivalents. Jones, Lawrence, and Hardy (2018) also described this effect at 'super-elite level' as the resilient and mind-set that BQ3 and BQ4s acquire throughout their development process, because of being younger and less mature compared to BQ1 and BQ2s.

In addition to the distribution of BQs in this current study, the total number of professional contracts awarded across the eleven seasons was 27 out of 364 players that have entered the academy. This figure demonstrates 7.4% of players graduated with a professional contract following their academy involvement, thus offering a potential benchmark to fellow Category 3 academies. Drawing upon this conversion value, it is essential to acknowledge the limited opportunities for young players who enter an academy to subsequently achieve professional status, thus emphasising the duel responsibility and importance of coaches to develop players holistically as people, as well as football young football players, through positive youth development (cf. Strachan, Cote, & Deakin, 2011).

Furthermore, it is important to recognise the issues surrounding external validity. For instance, the relatively newly formed under-23 league amongst Category 1 and 2 academies indicates the conversion figures would be significantly higher, as the requirement to participate at under-23 level for this status is mandatory when compared to Category 3 academies (The Premier League, 2011). In addition, Category 3 academies may have traditionally been acknowledged as a 'Centre of Excellence' prior to the reformed Elite Player Performance Plan (EPPP) category system in 2011 (The Premier League, 2011), which may have provided restricted opportunities to achieve professional status as a result of limited monetary resources and organisational structure. Therefore, the retrospective nature of this data may not provide a truly accurate insight of the opportunities that are apparent nowadays, thus coaches and practitioners are suggested to act with caution when interpreting the outcomes within a modern academy environment. With regards to the sample, whilst this observational case study only offers an insight into one professional football club, it is important to appreciate the novelty and accessibility to data of this nature, which may have been problematic to receive or unavailable elsewhere.

Conclusion

The holistic characteristics that have been discussed (i.e., technical, tactical, physical, and psychological factors), have previously been associated with both greater development outcomes and the successful transition from youth academy level to senior professional status. Therefore, these factors cannot be ignored whilst considering the socio-environmental dynamics, when incorporating new and innovative strategies to eliminate the RAE, within talent identification and development processes in academy football. As a result, whilst BQ4s may be less likely to be identified as 'talented' during the early stages of the development process, it appears they may be embarking in a long-term process that eventually sees them catch-up, and in some cases overtake, their older counterparts in BQ1. Thus, it is suggested coaches and practitioners should act with caution when creating strategies to eliminate the RAE, as doing so may also eradicate the UH. This is achieved likely through removing the natural developmental outcomes through a 'rocky road' that is created for significantly younger players whilst playing within a chronological age group (McCarthy & Collins, 2014). However, further research is required to fully understand why early disadvantage leads to greater opportunities. Furthermore, additional research into the proposed solutions for the RAE is required, to ensure there is a continued emphasis on creating the right environment for every player to develop to their full potential.

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The authors declare that they have no conflict of interest.

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List of tables and figures

Table 1. Quartile distributions with chi-square and Cramer's V outputs.

Quartile distributions (Expected percentages from ONS (2015))	BQ1 (*25.46%*)	BQ2 (*24.47%*)	BQ3 (*24.65%*)	BQ4 (*25.42%*)	Total	χ^2 (df = 3)	*P*	Cramer's V
Academy (***Expected from ONS distributions***)	224 (*141.56*)	168 (*136.05*)	88 (*137.05*)	76 (*141.34*)	556	103.57	**< .001**	0.305
Contracts awarded (***Expected from ONS distributions***)	5 (*6.87*)	8 (*6.61*)	6 (*6.66*)	8 (*6.86*)	27	1.06	.790	0.08
Contracts awarded (***Expected from academy distributions***)	5 (*10.88*)	8 (*8.16*)	6 (*4.27*)	8 (*3.69*)	27	8.92	**.03**	0.406

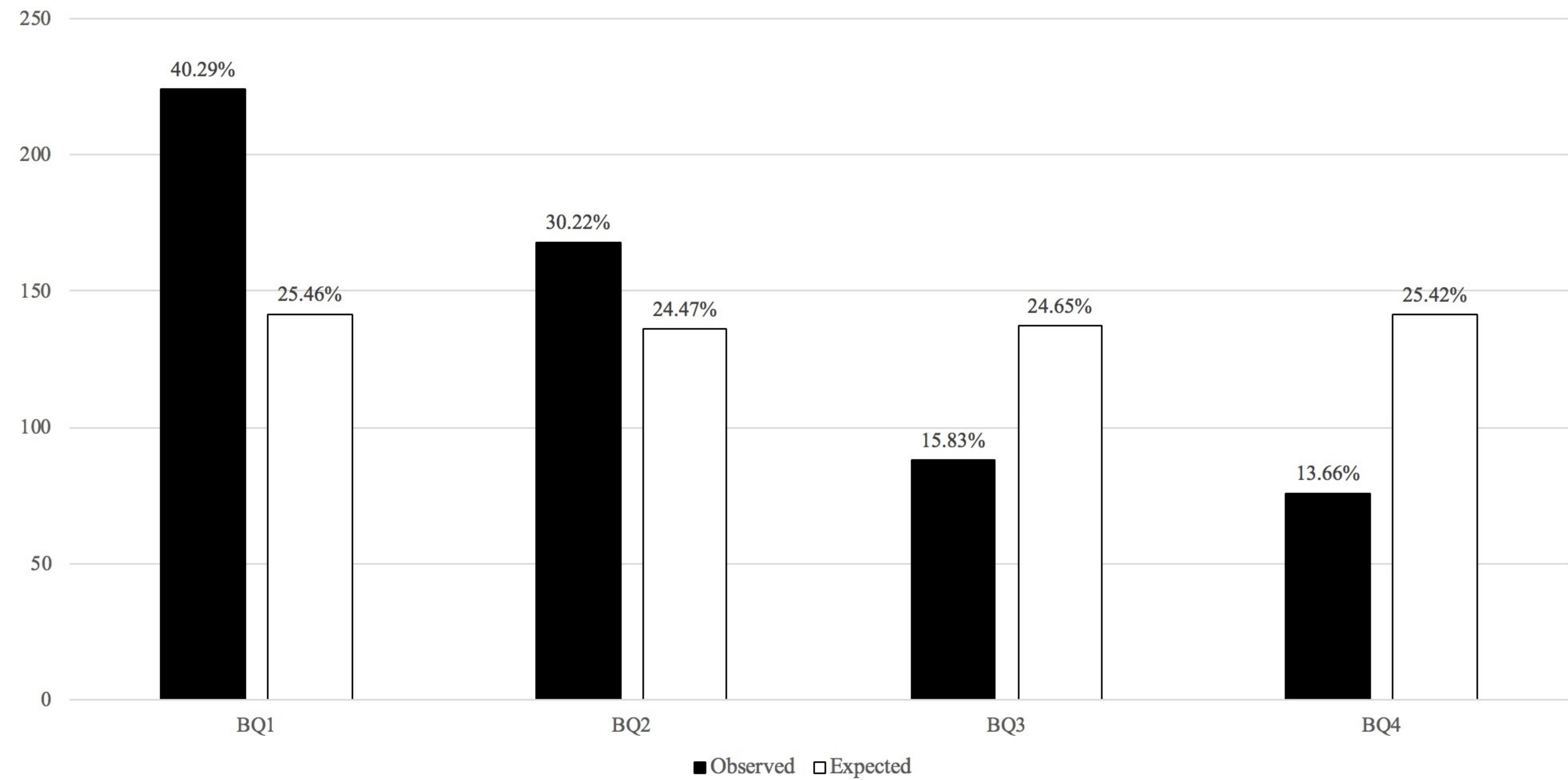

Figure 1. The RAE in academy football based on BQ distributions. Percentage of total is also represented above each BQ. Expected distributions calculated from ONS (2015).

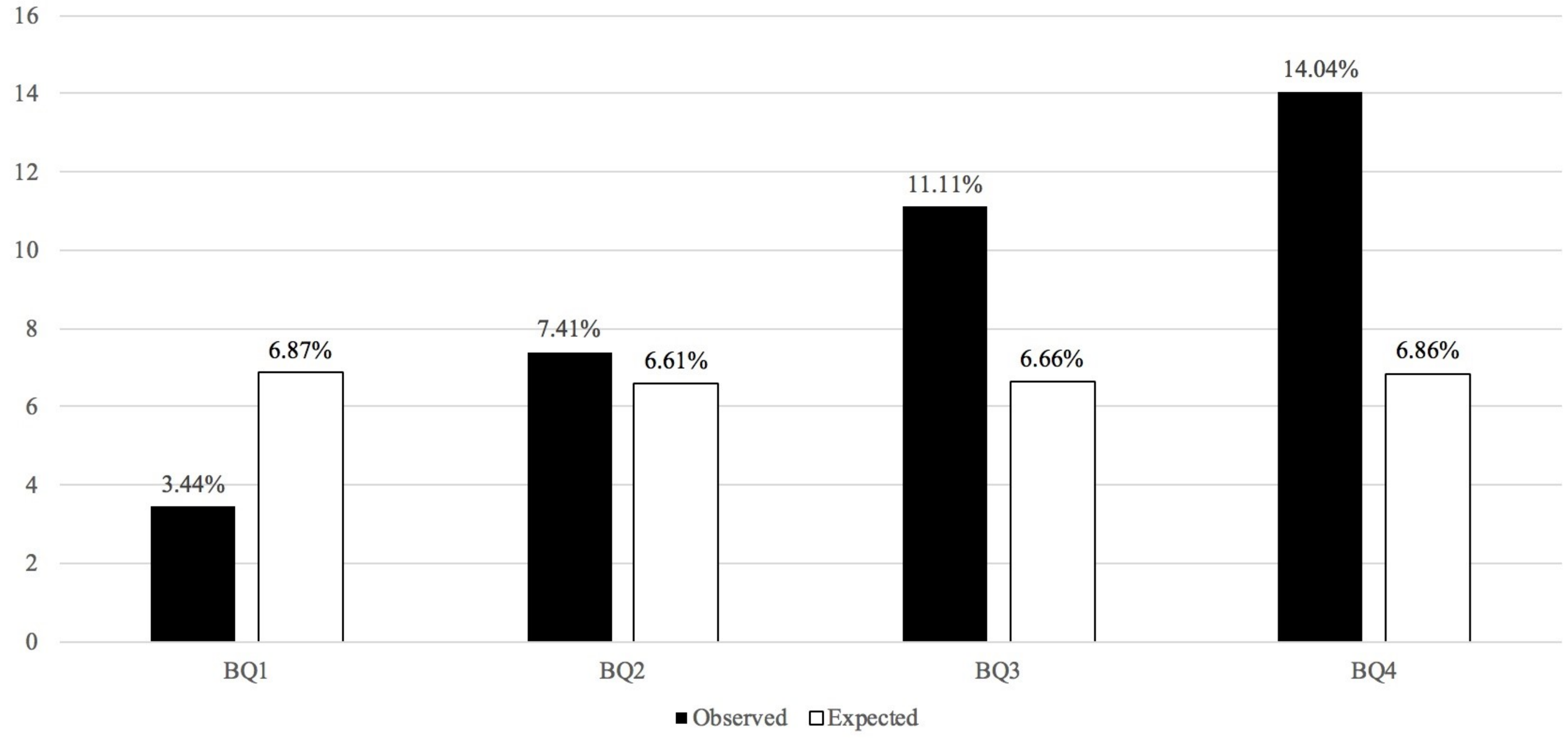

Figure 2. The percentage of professional contracts awarded based on the total number of academy graduates within each BQ.

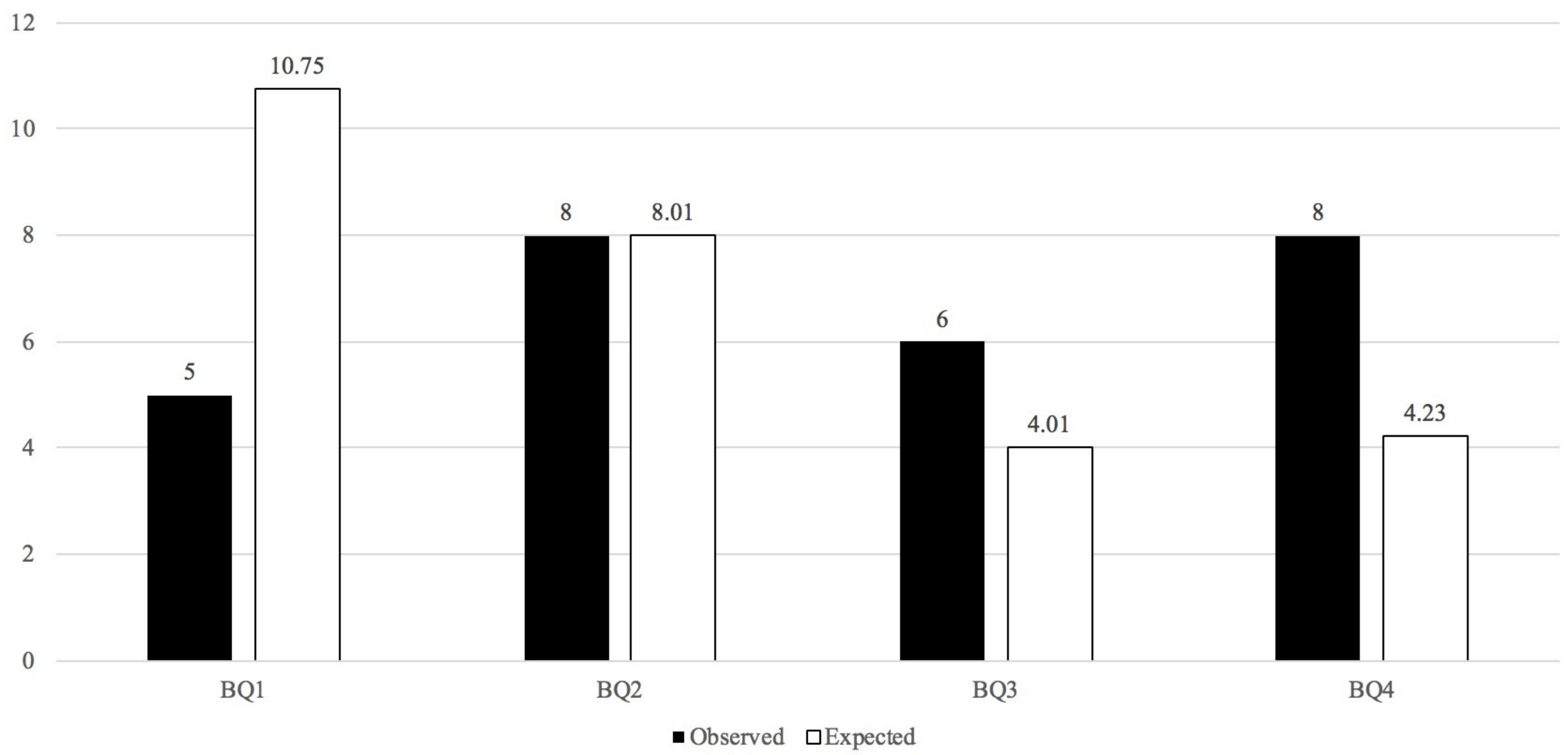

Figure 3. The total number of professional contracts awarded based on academy graduate BQ distributions.