International Journal of Applied Sports Sciences
2019, Vol. 31, No. 2, 101-114.
https://doi.org/10.24985/ijass.2019.31.2.101

ISSN 2233-7946 (Online)
ISSN 1598-2939 (Print)

Development of retirement age prediction model for athletes

Jin-Seok Chae*
Visiting Assistant Professor, Seoul national University of science and technology, Seoul, Korea

Abstract

The purpose of this study is to present retirement age predictive functions of athletes that can be utilized as data to reduce psychological shock of athletes from retirement and prepare for the future. To accomplish such purpose, athletes who retired as an undergraduate, unemployed or professional registered on the athlete registration system of the Korean Sport & Olympic Committee for three years were selected as the population. Stratified sampling was used for convenience sampling. Content validity of a retirement factor questionnaire was examined by consulting with experts. Opinions of 72 retirees were collected through an open questionnaire, and samples of 260 persons were used in the first and second parts after consulting with experts based on first sample data. The stepwise regression analysis method was applied to develop reliable and valid retirement predictive regression function. The degree of relevance was shown by multiple correlation coefficient between predicted age calculated by the predictive function and actual retirement age. Significance level was .05 for all tests. The 8 predictive function are presented according to the procedure above. $\widehat{Y}_1$(retirement age of female athlete)= 24.097+1.778*(physical limitation 11)-1.142*(job plan29), $\widehat{Y}_2$(retirement age of male athlete)= 23.498+1.334*(popularity 2)-1.126*(exercise attitude 20)+1.021*(competitiveness 7)-1.020* (job plan 29)+0.871*(economy 18)-1.905*(administration 22)-1.024*(administration 23)+.778*(interpersonal relationship 13), $\widehat{Y}_3$(retirement age of combat sports)=23.158+.688*(physical limitation 11)-1.790*(job plan 29)+0.960*(popularity 1)-0.656*(exercise attitude 16)+0.747*(job plan 33)+0.643*(economy 18)-0.461*(administration 23)+.606*(injury 46), $\widehat{Y}_4$(retirement age of non-combat sports)=20.741+ 1.637*(popularity 2)-1.270*(exercise attitude 20)+0.942*(competitiveness 7)+2.061*(family 5)-3.291*(administration 21)+1.082*(administration 25)+1.192(interpersonal relationship 8), $\widehat{Y}_5$(retirement age of individual sports)=27.414-1.295*(job plan 29)+1.463*(physical limitation 15)+0.972*(popularity 1)-0.639* (exercise 16), $\widehat{Y}_6$(retirement age of group sports)= 21.950+1.950*(popularity 2)-1.318*(exercise attitude 20)+4.635*(interpersonal relationship 6)-3.337*(addiction 41), $\widehat{Y}_7$(retirement age of undergraduate athlete)= 21.950+1.950*(popularity 2)-1.318*(exercise attitude 20)+4.635*(interpersonal relationship 6) -3.337*(addiction 41), $\widehat{Y}_8$(retirement age of unemployed and professional athlete)= 27.808-0.874* (exercise attitude 19)+1.287*(competitiveness 8)-1.402*(administration 21)+0.757*(popularity 2).

Key words: Retirement age, predictive functions, retirement factors, retired athletes

Introduction

According to an American medical news website called Medical News Today, a French institute for research in biomedicine and sports cognition named 'IRMES' conducted research on 'physical prime age' of athletes, which showed that male athletes enjoy their physical prime age in mid-20s.This study was carried out to find out physical prime age by comparing physical ability of 2,000 male athletes. Mean age at which athletes reach the peak of physical prowess was 26.1 years, and swimming athletes were found to experience prime age relatively early at an age of 21 years. Such changes in performance of athletes also agreed with the cycle of bodily changes including pulmonary functions(Dong-A Daily, 2015). In addition, athletes of the Korean national tea mare reported to retire at very young ages between 20s and 30s(Yong-Sik Lee, 2008). As such, athletes retire much earlier than other jobs. Most of athletes consider retiring after the age of 30 years. They would continue their athletic career if they are famous or acknowledged by team members (Kerr, Dacyshyn, 2000). However, since not all athletes are recognized and famous, they usually think about retirement after the age of 30 years (Sang-Deok Han, 1999). The biggest enemy of athletes is injury. An injured athlete cannot play sports during the recovery period, which leads to poor sensation. For this reason, athletes are most careful about injuries. A former member of the Korean national football team retired at a young age of 30 years because of an injury (Seok-Bae Lee, Mi-Hye Cho, 2012). Eitzen & Sage(1997) explained that mean duration of professional athletes is about 3-4 years, no matter how good their athletic performance may be.They mentioned that professional athletes start considering retirement in early or late 30s and when they are injured or become a substitute. Ok-Cheon Kim and Su-Won Lim(1999) reported that the biggest cause of retirement of professional athletes among voluntary and non-voluntary retirement problems is non-voluntary, one-sided removal by the team. Psychological conditions at the time of retirement include skepticism about sports, sense of betrayal about the team, perplexity, resentment, despondency and anxiety about future job(Coakley, 1983; Lerch, 1984; McKenna, Thomas, 2007; Ji-Hye Jeong, 2010; Yeon-Hee Seo, 2012; Du-Jae Park, Yeong-Jin Won, 2014). It would be desirable to recognize such problems of anxiety about retirement and suggest appropriate retirement age so that athletes can be helped mentally when they are about to give up on sports.

In relation to sports, studies were consistently conducted on predictive models for outcome prediction, ranking prediction, audience prediction and adolescent physique prediction(Cha-Yong Kim, 2001; Hyeong-Jun Choi, Ju-Hak Kim, 2006; Ju-hak Kim, Gab-Taek Noh, Jong-Seong Park, Won-Hee Lee, 2007; Jin-Seok Chae, Eun-Hyeong Cho, Han-Ju Eom, 2010; Jin-Seok Chae, 2012; Jin-Seok Chae, Jong-Guk Song, 2014, 2016; Bong-Ju Seong, Byeong-Gu Koh, 2017;Jin-Seok Chae, Jin Park, Wi-Yeong So, 2018). These studies are intended to predict future values based on actual measurement data, instead of using a survey tool to acquire data from human memory as done in this study.

Unwanted retirement due to unexpected removal from the team, injury, economic difficulty, physical limitation and accident would be shocking, not only for the athlete but also for family members. Athletes can gain mental stability and change job in a quick and effective way by preparing in advance. The purpose of this study is to present retirement age predictive functions for athletes to increase quality of life, reduce mental shock, and be used as data for future preparation.

Method

Research subjects

Since external validity that shows the degree of generalization of study results indicates how well

Submitted : 6 February 2019
Rivised : 1 April 2019
Accepted : 14 June 2019
Correspondence : chejinseok@hanmail.net

samples represent the population, the population of this study was defined as retired athletes who were active for three years or longer as an undergraduate, unemployed or professional athlete and can be found on the athlete registration system of the Korean Sport & Olympic Committee. Among study variables, the dependent variable was retirement age, presented for each sex (male/female), sports event(combat/ non-combat), organization of sports event(individual/ group) and affiliated team(undergraduate/unemployed /professional). Predictor variables included accident or addiction, job plan, family economy, decline in popularity, group life, injury, interpersonal relationship, competitiveness, exercise attitude and contract cancellation.

Data collection

To develop a predictive function that can predict retirement age more accurately, stratified sampling which can apply convenience sampling was used by defining retired athletes around the nation in university and beyond as the population. Validity of the open questionnaire was examined by consulting with retired athlete experts, and samples were collected. The open questionnaire was made using literature related to retirement factors utilized in previous studies(Ji-Hye Jeong, 2010; Seung-Hu Hong, 2010). Opinions of 72 retirees were collected using the open questionnaire, and they were largely classified into three domains including demographic variables after discussing with 12 experts (one doctoral research and 11 professors specialized in measurement evaluation). The first domain was personal domain divided into popularity, competitiveness, physical limitation, exercise attitude, group life and job plan. The second domain was external environment domain divided into accident, addiction and injury. The third domain was other people's domain divided into family, interpersonal relationship, economy and administration. (Jin-Seok Chae, Jin-I Shin, Deok-Hyeon Nam, 2018) As described above, the open questionnaire and main questionnaire (71 questions: 5-point scale comprised of strongly disagree, disagree, neither, agree and strongly agree) to predict retirement age were prepared through expert meetings to secure content validity. A total of 275 respondents participated in the questionnaire in the first and second parts combined. Among them, data with insincere responses or many missing values were excluded to use 260 responses for analysis. Characteristics of the subjects are presented in <Table 1>.

Data processing method

Predictor variables to be applied first to the predictive regression functions were comprised of questions (Table 3) obtained by performing exploratory factor analysis to secure validity of the questionnaire. For exploratory factor analysis, factors were extracted using the maximum likelihood method. Questions with eigen value of 1.0 or above and factor loading of .45 or above were included in the same factor(Tabachnick & Fidell, 1989). By performing exploratory factor analysis on the questionnaire, 13 retirement factors were reduced to 10 latent variables (accident and addiction, job plan, family economy, decline in popularity, group life, injury, interpersonal relationship, competitiveness, exercise attitude and contract cancellation)(Table 3). Based on

Table 1. *Characteristics of retired subjects*

Item	Level	n	%
Sex	Female	62	23.8
	Male	198	76.2
Retirement age	Early 20s	138	53.1
	Late 20s	77	29.6
	30s or above	45	17.3
Characteristics of sports	Combat sports	128	49.2
	Non-combat sports	132	50.8
Composition of sports	Individual sports	169	65.0
	Group sports	91	35.0
Affiliation	University team	121	46.5
	Unemployed team	97	37.3
	Professional team	42	16.2

Table 2. Analysis of open questionnaire on causes of retirement n=72

Sex	Sports Event	Cause 1	Cause 2	Cause 3	Cause 4
Male	Football, baseball, basketball, volleyball, handball, hockey	1.Injury (cruciate ligament,waist,ankles,shoulders)	2. Contract failure, weakened competitiveness, retirement recommendation due to aging	3. Low salary, groping for another job,schooling	4. Failure to adapt to team,violence, harassment of seniors, military service
	Badminton,track,weightlifting, swimming, shooting, canoe, speed,skate,dance sports,table tennis,tennis, archery	1. Frequent injuryand surgery	2.Poor performance,lack of skills	3.Career,future uncertainty	4.Military service,studying abroad, retirementrecommendation, skepticism about sports
	Taekwondo,judo	1.Injuryand surgery	2. Extended schooling, poor academic performance	3. Family environment,recommendation	4. Concern for future
Female	Football,handball,hockey	1.Injury	2. Failure to joinunemployed team	3.Failure to adapt	4.Loss of interest
	Badminton,dance sports,tennis,archery	1.Frequent injury, physical limitation	2. Poor academic performance, recommendation of parent, teacher or leader	3.Unclear future,another job	4. Team circumstances
	Taekwondo	1.Injury	2. Poor athletic performance, poor competition result, elimination from national team	3.Career,cannot play for lifetime	4. Loss of interest

normal distribution of data verified according to mean, standard deviation, skewness and kurtosis of measurement variables, the range of mean was 1.568~2.918 and the distribution of standard deviation was 0.817~1.315. The range of skewness was -0.080~1.687, whose absolute value is not greater than 3.0. The range of kurtosis was -1.145~2.588, whose absolute value is not greater than 10. Therefore, the distribution of data had normality (Kline 2005). The dependent variable of the predictive regression function was retirement age. The predictive regression function was divided into 8 predictive model functions based on stepwise regression analysis according to sex, combat/non-combat, individual/group and affiliation (undergraduate, unemployed, professional). For verification, the degree of relevance was shown by multiple correlation coefficient between predicted age calculated by the predictive function and actual retirement age(Table 13). Data collected during this study were entered into Excel 2007 and converted on the SPSS 22.0 program for analysis.

Statistics

The correlation analysis was used to examine the relevance among predictor variables or retirement factors. The predictive models presented as the study results used the stepwise regression analysis method, which is a general predictive statistical analysis method used when the dependent variable is a continuous variable. Predictor variables were extracted through exploratory factor analysis, and inter-item consistency of the measurement tool was verified using Cronbach's

Table 3. *Structure matrix for latent variables*

	Accident and addiction	Job plan	Family economy	Decline in popularity	Group life	Injury	Interpersonal relationship	Competitiveness	Exercise attitude	Contract cancellation	Cronbach's α
Addiction 39	.961	.106	.529	.176	-.471	.314	-.595	-.260	.310	-.568	
Addiction 40	.953	.104	.518	.163	-.416	.299	-.590	-.266	.317	-.562	
Accident38	.952	.081	.550	.159	-.463	.288	-.589	-.260	.288	-.559	
Addiction 41	.937	.106	.535	.198	-.502	.324	-.608	-.290	.319	-.575	
Accident37	.929	.106	.568	.199	-.541	.339	-.614	-.281	.308	-.604	.975
Addiction 42	.901	.104	.511	.198	-.478	.313	-.561	-.290	.314	-.514	
Accident 36	.880	.126	.586	.180	-.518	.310	-.605	-.294	.322	-.536	
Administration20	.820	.122	.597	.237	-.425	.298	-.651	-.311	.305	-.739	
Administration 21	.787	.127	.577	.172	-.450	.312	-.656	-.295	.262	-.769	
Job plan 31	.014	.899	.088	-.027	-.081	-.045	-.122	-.266	.256	-.007	
Job plan 32	.144	.851	.231	-.053	-.209	.066	-.158	-.279	.415	-.154	
Exercise attitude19	.165	.771	.207	-.090	-.218	-.059	-.100	-.262	.530	-.127	
Job plan 33	.116	.760	.246	-.063	-.113	.025	-.222	-.312	.325	-.117	.895
Job plan 30	.185	.747	.227	-.016	-.357	.048	-.172	-.246	.361	-.194	
Job plan29	.111	.712	.183	.067	-.089	.061	-.148	-.244	.290	-.136	
Job plan 28	.056	.496	.084	.114	-.035	.026	-.041	.011	.262	-.134	
Family 4	.461	.101	.909	.250	-.393	.223	-.467	-.276	.245	-.420	
Family 3	.487	.122	.867	.173	-.418	.217	-.481	-.262	.256	-.494	
Family 5	.654	.101	.841	.218	-.417	.283	-.586	-.307	.299	-.511	
Interpersonal relationship 6	.671	.115	.826	.175	-.460	.295	-.642	-.295	.276	-.612	
Family 1	.442	.154	.794	.151	-.371	.220	-.465	-.288	.206	-.368	
Economy 18	.434	.241	.768	.073	-.459	.347	-.589	-.364	.296	-.561	.943
Family 2	.432	.221	.753	.085	-.370	.349	-.534	-.277	.223	-.374	
Economy 14	.398	.322	.724	.009	-.372	.237	-.494	-.321	.267	-.471	
Economy 15	.448	.195	.720	.114	-.458	.370	-.498	-.393	.214	-.565	
Economy 16	.585	.133	.702	.184	-.451	.369	-.557	-.330	.284	-.686	
Popularity 2	.163	-.075	.113	.922	-.117	.015	-.059	.021	-.009	-.177	
Popularity 3	.223	-.099	.195	.867	-.185	.061	-.049	-.002	-.015	-.225	.795
Popularity 1	.124	.222	.202	.514	-.088	-.113	-.045	-.264	.230	-.189	
Group life 24	.591	.173	.569	.204	-.923	.280	-.483	-.326	.403	-.485	
Group life 25	.576	.153	.569	.169	-.854	.296	-.522	-.318	.401	-.443	
Group life 23	.631	.179	.557	.245	-.805	.269	-.478	-.343	.400	-.552	.904
Group life 22	.429	.208	.442	.155	-.636	.146	-.431	-.343	.542	-.385	
Job plan29	.426	.407	.406	.101	-.609	.224	-.348	-.325	.335	-.332	
Injury 43	.133	-.026	.139	.007	-.079	.842	-.186	.002	-.041	-.120	
Injury 46	.184	.014	.246	-.045	-.224	.831	-.271	.023	-.008	-.208	.867
Injury 45	.431	-.011	.299	-.046	-.303	.784	-.314	-.044	.113	-.415	
Injury 44	.351	.070	.315	.013	-.222	.754	-.288	-.061	.040	-.257	
Interpersonal relationship 9	.547	.169	.539	.089	-.343	.326	-.927	-.238	.221	-.490	
Interpersonal relationship 13	.548	.119	.513	-.005	-.333	.265	-.884	-.282	.215	-.429	
Interpersonal relationship 8	.635	.137	.548	.043	-.408	.298	-.869	-.203	.236	-.512	.943
Interpersonal relationship 10	.585	.157	.615	.062	-.440	.307	-.834	-.226	.268	-.566	
Interpersonal relationship 12	.727	.147	.610	.136	-.464	.283	-.802	-.303	.248	-.636	
Competitiveness 5	.251	.246	.321	.100	-.315	.035	-.259	-.791	.314	-.263	
Competitiveness 4	.243	.187	.341	.153	-.236	.051	-.237	-.777	.117	-.247	
Competitiveness 8	.299	.080	.350	-.005	-.300	.079	-.290	-.718	.176	-.230	.864
Competitiveness 6	.195	.429	.218	-.074	-.110	-.035	-.192	-.713	.355	-.136	
Competitiveness 9	.313	.286	.285	.102	-.368	.059	-.241	-.666	.469	-.252	
Competitiveness 7	.236	.199	.260	.095	-.190	.032	-.229	-.654	.428	-.164	
Exercise attitude 16	.333	.367	.240	.045	-.337	-.020	-.188	-.304	.868	-.297	
Exercise attitude17	.274	.464	.273	-.046	-.242	.022	-.282	-.307	.835	-.182	
Group life 21	.324	.336	.347	.054	-.381	.123	-.282	-.280	.812	-.257	
Exercise attitude 20	.257	.350	.212	.063	-.308	.002	-.180	-.235	.805	-.139	.887
Physical limitation13	.369	.252	.340	.163	-.387	.072	-.251	-.405	.625	-.272	
Exercise attitude 18	.483	.418	.356	.153	-.438	.154	-.322	-.321	.572	-.327	
Physical limitation15	.376	.132	.381	.187	-.367	.158	-.384	-.400	.477	-.307	
Administration 21	.744	.108	.554	.191	-.438	.296	-.630	-.238	.267	-.849	
Administration23	.564	.156	.541	.222	-.408	.328	-.541	-.270	.194	-.836	.933
Administration 24	.650	.127	.605	.250	-.410	.334	-.606	-.333	.282	-.819	
Administration 25	.567	.095	.529	.244	-.424	.283	-.533	-.258	.250	-.799	
Eigenvalue	23.831	6.035	2.937	2.575	2.267	2.131	1.987	1.388	1.277	1.119	
Explanation ratio (%)	38.317	9.705	3.946	3.987	2.869	3.420	2.117	2.588	2.445	1.622	
Cumulativeratio (%)	38.317	48.021	51.967	55.954	58.823	62.243	64.360	66.948	69.393	71.015	
Rotation sums of squared loadings	16.727	6.244	15.050	3.032	10.120	5.593	13.648	7.265	8.284	12.442	

Item		Value
KMO		.931
Bartlett's test	x^2	14229
	df	1770
	p	.001

α. The verification method was the Pearson's product-moment correlation coefficient between predicted retirement age and actual age. Significance level was .05 for all verifications.

Results

This study first presented the correlation coefficient among retirement factors (Table 4). The first predictive functions are retirement age predictive models according to sex. The second predictive functions are retirement age predictive models according to characteristics of sports. The third predictive functions are retirement age predictive models according to number of athletes in a team. The fourth predictive functions are retirement age predictive models according to affiliation.

Retirement age predictive models according to sex

The retirement age predictive function of female athlete was presented using stepwise regression analysis(Table 5). There are two significant predictor variables including physical limitation 11 and job plan 29.Explanation power of predictor

Table 4. *Correlation analysis among retirement factors*

	Retirement age	Accident and addiction	Job plan	Family economy	Popularity	Group life	Injury	Interpersonal relationship	Competitiveness	Exercise life
Retirement age	1									
Accident and addiction	.041	1								
Job plan	-.003	.273**	1							
Family economy	.146*	.625**	.401**	1						
Popularity	.344**	.235**	.152*	.225**	1					
Group life	-.099	.480**	.544**	.460**	.120	1				
Injury	.073	.351**	.111	.371**	.006	.145*	1			
Interpersonal relationship	.073	.714**	.282**	.654**	.115	.398**	.335**	1		
Competitiveness	.097	.382**	.426**	.430**	.155*	.466**	.067	.337**	1	
Exercise attitude	-.158*	.334**	.601**	.358**	.041	.926**	.054	.276**	.417**	1
Contract cancellation	.105	.773**	.323**	.758**	.288**	.463**	.390**	.722**	.425**	.317**

*p<.05, **p<.01

Table 5. *Result of stepwise regression analysis to predict retirement age of female athlete*

	Predictor Variable	Unstandardized Coefficient		Standardized Coefficient	t	p	Partial Correlation	VIF
		B	SD	β				
1 Model	(Constant)	27.302	.878		31.079	.000		
	Job plan 29	-.911	.358	-.231	-2.546	.012	-.231	1.000
2 Model	(Constant)	24.097	.760		31.702	.000		
	Physical limitation 11	1.778	.286	.407	6.213	.000	.386	1.112
	Job plan 29	-1.142	.296	-.252	-3.853	.000	-.239	1.112

a. Dependent variable: Retirement age.

b. 2model:F=7.820** $R^2(Adjusted R^2) = .190(.160)$

c. Predictive function: Y(retirement age)= 24.097+1.778*(physical limitation 11)-1.142*(job plan 29) variables in explaining fluctuation of the dependent variable is 19.0%, but modified explanation power is 16.0%. In addition, the fitness of this regression model is satisfactory (F=7.820**, p<.05). The retirement age predictive function of female athlete is Y(retirement age)=24.097+1.778*(physical limitation 11)-1.142* (job plan 29).

There are 8 significant predictor variables for male athletes including popularity 2, exercise attitude20, popularity 1, competitiveness 7, job plan 29, economy 18, administration 23 and interpersonal relationship 13. Explanation power of the regression model is 31.0%, and modified explanation power is 27.6%. The fitness of this regression model is satisfactory (F=9.101, p<.05). The retirement age predictive function of male athlete isY(retirement age)= 23.498+1.334*(popularity 2) -1.126*(exercise attitude 20)+1.021*(competitiveness 7)-1.020*(job plan 29)+0.871*(economy 18) -1.905* (administration 22)-1.024*(administration 23) +.778* (interpersonal relationship 13)(Table 6).

Retirement age predictive models according to characteristics of sports

The predictive function of combat sports was derived by stepwise regression analysis with six predictor variables(job plan 29, physical limitation 15, popularity 1, exercise attitude 16, job plan 30 and injury 46). The explanation power of the regression model is 23.9%. The fitness of the regression model is satisfactory (F=8.311**, p<.05). Job plan 29(β=-.516) was found to be the variable that has the greatest impact on retirement age among retirement factors. The retirement age predictive function of combat sports is Y(retirement age)=23.158+.688*(physical limitation 11)-1.790*(job plan 29)+0.960*(popularity 1)-0.656*(exercise attitude 16)+0.747*(job plan 33)+0.643*(economy 18)-0.461 *(administration 23)+.606*(injury 46)(Table 7).

There are 7 predictor variables for the predictive function of non-combat sports including popularity 2,exercise attitude20, competitiveness 7, family 5, administration 21, administration 25 and interpersonal relationship 8. The modified explanation power is 43.1%. In addition, the fitness of the regression model is satisfactory(F=13.016**, p<.05). Among retirement factors, administration 21(β=.-457) had the biggest effect

Table 6. Result of stepwise regression analysis to predict retirement age of male athlete

Model	Predictor Variable	Unstandardized Coefficient		Standardized Coefficient	t	p	Partial Correlation	VIF
		B	SD	β				
1 Model	(Constant)	23.029	.789		29.184	.000		
	Popularity 2	1.292	.304	.311	4.252	.000	.311	1.000
.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.
8 Model	(Constant)	23.498	1.063		22.096	.000		
	Popularity 2	1.334	.282	.321	4.728	.000	.348	1.082
	Exercise attitude 20	-1.126	.299	-.286	-3.760	.000	-.283	1.356
	Competitiveness7	1.021	.274	.267	3.723	.000	.281	1.209
	Job plan 29	-1.020	.355	-.226	-2.873	.005	-.220	1.457
	Economy18	.871	.362	.204	2.408	.017	.186	1.690
	Administration 22	-1.905	.506	-.410	-3.765	.000	-.284	2.784
	Administration 23	1.024	.431	.242	2.378	.019	.184	2.421
	Interpersonal relationship 13	.778	.368	.181	2.115	.036	.164	1.710

a. Dependent variable: Retirement age

b. 8 model:F=9.101** $R^2(Adjusted R^2) = .310(.276)$

c. Predictive function: Y(retirement age)= 23.498+1.334*(popularity 2)-1.126*(exercise attitude 20)+1.021*(competitiveness 7)-1.020*(job plan 29)+0.871*(economy 18)-1.905*(administration 22)-1.024*(administration 23)+.778*(interpersonal relationship13) on retirement age. The retirement age predictive function of non-combat sports is Y(retirement age)= 20.741+1.637*(popularity 2)-1.270*(exercise attitude 20)+0.942*(competitiveness 7)+2.061*(family 5)-3.291 *(administration 21)+1.082*(administration 25)+1.192 (interpersonal relationship 8)(Table 8).

Retirement age predictive models according to number of members in a team

There are four predictor variables for the predictive function of individual sports including job plan29, physical limitation15, popularity 1 and exercise attitude16. The modified explanation power of the regression model is 19.6%. In addition, the fitness of the regression model is satisfactory(F=10.346, p<.05). Among retirement factors, physical limitation 15(β=.359) was found to be the variable that has the biggest effect on retirement age. The retirement age

***Table 7.** Result of stepwise regression analysis to predict retirement age of combat sports athlete*

Model	Predictor Variable	Unstandardized Coefficient		Standardized Coefficient	*t*	*p*	Partial Correlation	VIF
		B	SD	*β*				
1 Model	(Constant)	27.302	.878		31.079	.000		
	Job plan 29	-.911	.358	-.231	-2.546	.012	-.231	1.000
.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.
6 Model	(Constant)	22.069	1.355		16.288	.000		
	Job plan 29	-2.033	.398	-.516	-5.103	.000	-.438	1.634
	Physical limitation 15	1.414	.387	.333	3.655	.000	.329	1.326
	Popularity 1	1.164	.330	.302	3.533	.001	.319	1.168
	Exercise attitude 16	-.925	.320	-.263	-2.893	.005	-.266	1.318
	Job plan30	.948	.351	.266	2.704	.008	.250	1.545
	Injury 46	.598	.264	.191	2.266	.025	.211	1.137

a. Dependent variable: Retirement age

b. 6model:F=8.311** $R^2(Adjusted R^2) = .312(.274)$

c. Predictive function: Y(retirement age)= 22.069-2.033*(job plan 29)+1.414*(physical limitation 15)+1.164*(popularity 1)-0.925*(exercise attitude 16)+0.948*(job plan 30)+598*(injury 46)

***Table 8.** Result of stepwise regression analysis to predict retirement age of non-combat sports athlete*

Model	Predictor Variable	Unstandardized Coefficient		Standardized Coefficient	*t*	*p*	Partial Correlation	VIF
		B	SD	*β*				
1 Model	(Constant)	21.597	.937		23.049	.000		
	Popularity 2	1.777	.357	.428	4.972	.000	.428	1.000
.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.
7 Model	(Constant)	20.741	1.192		17.400	.000		
	Popularity 2	1.637	.314	.395	5.210	.000	.455	1.119
	Exercise attitude 20	-1.270	.284	-.340	-4.463	.000	-.401	1.134
	Competitiveness 7	.942	.307	.237	3.069	.003	.288	1.167
	Family 5	2.061	.699	.307	2.949	.004	.278	2.113
	Administration 21	-3.291	.777	-.457	-4.233	.000	-.383	2.278
	Administration 25	1.082	.444	.213	2.435	.017	.232	1.494
	Interpersonalrelationship 8	1.192	.569	.199	2.094	.039	.201	1.767

a. Dependent variable: Retirement age

b. 7model:F=13.016** $R^2(Adjusted R^2) = .467(.431)$

c.Predictive function: Y(retirement age)= 20.741+1.637*(popularity 2)-1.270*(exercise attitude 20)+0.942*(competitiveness 7)+2.061*(family)-3.291*(administration 21)+1.082*(administration 25)+1.192*(interpersonal relationship8) predictive function of individual sports is Y(retirement age)= 27.414-1.295*(job plan 29)+1.463*(physical limitation 15)+0.972*(popularity 1)-0.639*(exercise attitude 16)(Table 9).

There are four predictor variables for the predictive function of group sports including popularity 2, exercise attitude 20, interpersonal relationship 6 and addiction 41. The modified explanation power of the regression model is 43.6%. In addition, the fitness of the regression model is satisfactory (F=15.287, p<.05). Among retirement factors, interpersonal relationship 6(β=.648) is the variable that has the biggest effect on retirement age. The retirement age predictive function of group sports is Y(retirement age)= 21.950+1.950*(popularity 2)-1.318*(exercise attitude 20)+4.635*(interpersonal relationship 6)-3.337*(addiction 41)(Table 10).

Table 9. *Result of stepwise regression analysis to predict retirement age of individual sports athlete*

Model	Predictor Variable	Unstandardized Coefficient		Standardized Coefficient	*t*	*p*	Partial Correlation	VIF
		B	SD	β				
1 Model	(Constant)	27.414	.738		37.135	.000		
	Jobplan 29	-.920	.306	-.237	-3.011	.003	-.237	1.000
.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.
4 Model	(Constant)	23.983	1.101		21.776	.000		
	Jobplan 29	-1.295	.302	-.334	-4.290	.000	-.332	1.153
	Physical limitation 15	1.463	.339	.359	4.320	.000	.334	1.315
	Popularity 1	.972	.274	.264	3.553	.001	.279	1.048
	Exercise attitude 16	-.639	.272	-.194	-2.349	.020	-.189	1.303

a. Dependent variable: Retirement age

b. 4model:F=10.346** $R^2(Adjusted\,R^2) = .217(.196)$

c. Predictive function: Y(retirement age)= 27.414-1.295*(job plan 29)+1.463*(physical limitation 15)+0.972*(popularity 1)-0.639*(exercise attitude 16)

Table 10. *Result of stepwise regression analysis to predict retirement age of group sports athlete*

Model	Predictor Variable	Unstandardized Coefficient		Standardized Coefficient	*t*	*p*	Partial Correlation	VIF
		B	SD	β				
1 Model	(Constant)	21.569	1.194		18.058	.000		
	Popularity 2	1.891	.473	.424	4.001	.000	.424	1.000
.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.
4 Model	(Constant)	21.950	1.382		15.878	.000		
	Popularity 2	1.950	.408	.437	4.779	.000	.496	1.098
	Exerciseattitude 20	-1.318	.402	-.305	-3.277	.002	-.365	1.134
	Interpersonal relationship6	4.635	.951	.648	4.875	.000	.503	2.320
	Addiction 41	-3.337	1.039	-.453	-3.211	.002	-.358	2.611

a. Dependent variable: Retirement age

b. 4model:F=15.287** $R^2(Adjusted\,R^2) = .466(.436)$

c. Predictive function: Y(retirement age)= 21.950+1.950*(popularity 2)-1.318*(exercise attitude 20)+4.635*(interpersonal relationship 6)-3.337*(addiction 41)

Retirement age predictive model according to affiliation

Multiple regression analysis was used to present the retirement age predictive function of undergraduate athlete. Predictor variables include economy 18, economy 16, administration 21 and competitiveness 4. The modified explanatory power of the regression model is 26.0%. In addition, the fitness of the regression model is satisfactory (F=10.754**, p<.05). Among retirement factors, economy 16(β=-.732) is the variable that has the biggest effect on retirement age. The retirement age predictive function of undergraduate athlete is Y(retirement age)=22.186+1.559*(economy 18)-1.889*(economy 16)+1.298*(administration 21) -0.453*(competitiveness 4)(Table 11).

Multiple regression analysis was used to present the

Table 11. *Result of stepwise regression analysis to predict retirement age of undergraduate athlete*

Model	Predictor Variable	Unstandardized Coefficient		Standardized Coefficient	t	p	Partial Correlation	VIF
		B	SD	β				
1 Model	(Constant)	21.328	.415		51.358	.000		
	Economy 18	.848	.214	.353	3.960	.000	.353	1.000
.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.
4 Model	(Constant)	22.186	.528		42.032	.000		
	Economy 18	1.559	.321	.649	4.856	.000	.425	2.683
	Economy 16	-1.889	.448	-.732	-4.218	.000	-.378	4.512
	Administration 21	1.298	.333	.538	3.899	.000	.353	2.855
	Competitiveness 4	-.453	.195	-.200	-2.315	.022	-.218	1.114

a. Dependent variable: Retirement age

b. 4model:F=10.754** $R^2(Adjusted R^2) = .287(.260)$

c. Predictive function: Y(retirement age)= 22.186+1.559*(economy 18)-1.889*(economy 16)+1.298*(administration 21)-0.453*(competitiveness 4)

Table 12. *Result of stepwise regression analysis to predict retirement age of unemployed and professional athlete*

Model	Predictor Variable	Unstandardized Coefficient		Standardized Coefficient	t	p	Partial Correlation	VIF
		B	SD	β				
1 Model	(Constant)	30.736	.793		38.775	.000		
	Exerciseattitude 19	-1.021	.290	-.312	-3.521	.001	-.312	1.000
.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.
4 Model	(Constant)	27.808	1.421		19.570	.000		
	Exerciseattitude 19	-.874	.283	-.267	-3.084	.003	-.280	1.135
	Competitiveness 8	1.287	.346	.318	3.718	.000	.331	1.105
	Administration 21	-1.402	.381	-.315	-3.679	.000	-.328	1.113
	Popularity 2	.757	.316	.206	2.397	.018	.221	1.116

a. Dependent variable: Retirement age

b. 4model:F=9.880** $R^2(Adjusted R^2) = .261(.234)$

c. Predictive function: Y(retirement age)= 27.808-0.874*(exercise attitude 19)+1.287*(competitiveness8)-1.402*(administration 21)+0.757*(popularity 2) retirement age predictive function of unemployed and professional athlete. There are four predictor variables including exercise attitude 19, competitiveness 8, administration 21 and popularity 2. The modified explanation power of the regression model is 23.4%. In addition, the fitness of the regression model is satisfactory(F=9.880**, p<.05). Among retirement factors, competitiveness 8(β=.318) was found to be the variable that has the biggest effect on retirement age. The retirement age predictive function of unemployed and professional athlete is Y(retirement age)= 27.808 -0.874*(exercise attitude 19)+1.287* (competitiveness 8)-1.402*(administration 21)+0.757 *(popularity 2) (Table 12).

Verification of retirement age predictive functions

The degree of relevance was shown by the multiple correlation coefficient between predicted age calculated using the retirement age predictive functions presented in the study results and actual retirement age. As shown in <Table 13>, all 8 models showed significant (**p<.05) relevance between predicted value and actual value.

Discussion

Prediction is difficult, but it is also difficult to develop reliable and valid predictive functions. There is a greater difficulty in developing retirement age predictive functions for athletes because injury occurs unexpectedly in many cases. Nonetheless, 8 retirement age predictive functions for athletes were presented by increasing the number of samples in the retirement factor measurement tool developed by Jin-Seok Chae, Jin-Lee Shin and Deok-Hyeon Nam (2018) to reduce mental shock and prepare for the future of athletes. Discussions are as follows.

First, the 8 retirement age predictive models are created using stepwise regression analysis according to characteristics of athletes. As a result of applying 60 variables obtained by dimension reduction of data taken using the questionnaire of previous studies with increased number of samples through exploratory factor analysis, when classified according to sex, two significant predictor variables including physical limitation 11 and job plan 29 were obtained for the model of female athlete and 8 variables including popularity 2, exercise attitude 20, popularity 1, competitiveness 7, job plan 29, economy 18, administration 23 and interpersonal relationship 13 were obtained for the model of male athlete. In addition, for combat and non-combat sports classified based on face-to-face combat of athletes, six variables including job plan 29, physical limitation 15, popularity 1, exercise attitude 16, job plan 30 and injury 46 were obtained for combat sports and 7 variables including popularity 2, exercise attitude 20, competitiveness 7, family 5, administration 21, administration 25 and interpersonal relationship 8 were obtained for

Table 13. *Degree of correlation between predicted age and actual age*

Classification	Model	Predicted Value	Actual Value Actual Retirement Age
Classification by sex	1Model	Predicted age of femaleathlete	.417**
	2Model	Predicted age of maleathlete	.534**
Classification by characteristics of sports	3Model	Predicted age of combat sportsathlete	.550**
	4Model	Predicted age of non-combat sportsathlete	.596**
Classification by composition of sports	5Model	Predicted age of individual sportsathlete	.381**
	6Model	Predicted age of group sportsathlete	.660**
Classification by team affiliation	7Model	Predicted age of undergraduateathlete	.520**
	8Model	Predicted age of unemployed and professionalathlete	.454**

**p<.01

non-combat sports.

When classified into individual sports and group sports based on number of members in a team,four significant predictor variables (job plan 29, physical limitation 15, popularity 1 and exercise attitude) were obtained for individual sports and four variables including popularity 2, exercise attitude 20, interpersonal relationship 6 and addiction 41 were obtained for group sports. Lastly, team affiliation was divided into university, unemployed and professional. Four significant predictor variables (economy 18, economy 16, administration 21 and competitiveness 4) were selected for undergraduate athletes and four predictor variables (exercise attitude 19, competitiveness 8, administration 21 and popularity 2) were obtained for unemployed and professional athletes.

There was no previous study that presented predictive functions related to retirement age.The method of this study partially agreed with the method of Bong-Ju Seong and Byeong-Gu Koh(2017) who developed a physical age predictive function for adult men and women, but there were differences in verification methods. In addition, Laval lee, Grove and Gordon (1997) who studied causes of retirement of Australian elite athletes reported schooling, decline in performance, economic difficulty and loss of interest as causes of retirement. These causes partially agreed with the independent variables for the retirement age predictive functions of this study including economic difficulty, job plan and exercise attitude. In a study on active female basketball players of the national team, Ji-Hye Jeong(2010) reported admission to higher school, path of a leader, honorable retirement and family life as causes of retirement, which agree with job plan, honorable retirement and school admission of this study. Hee-Yun Choi and Yong-CheolJeong (2012). reported that the basic rights of female handball players are seriously violated and depicted routine violence of leaders and seniors and frequent injury as causes of retirement. These causes were associated with group life and injury of this study.

Mean retirement age of women was found to be 22 years in a previous study by Job Korea (2017), but it was 23.73 years in this study. In relation to retirement age, Yong-Sik Lee (2008) reported that athletes of the national team generally retire in their 20s and 30s, and Job Korea (2017)reported mean retirement age to be about 22 years for female athletes of Korea and about 28 years for male athletes. These results are similar to the result of this study, which showed mean retirement age of about 25.84 years for men and women combined.

Conclusion and Suggestion

First, the retirement age predictive function of female athlete is Y(retirement age)= 24.097+1.778*(physical limitation 11)-1.142*(job plan29). Second, the retirement age predictive function of male athlete is Y= 23.498+1.334*(popularity 2)-1.126*(exercise attitude 20)+1.021*(competitiveness 7)-1.020*(job plan 29) +0.871*(economy 18)-1.905*(administration 22) -1.024*(administration 23)+.778*(interpersonal relationship 13). Third is the retirement age predictive function of combat sports athlete. The predictive function is Y(retirement age)=23.158+.688*(physical limitation 11)-1.790*(job plan 29)+0.960*(popularity 1)-0.656*(exercise attitude 16)+0.747*(job plan 33)+0.643*(economy 18)-0.461*(administration 23)+ .606*(injury 46). Fourth is the retirement age predictive function of non-combat sports athlete. The predictive function is Y(retirement age)= 20.741 +1.637*(popularity 2) -1.270*(exercise attitude 20) +0.942*(competitiveness 7)+2.061*(family 5)-3.291* (administration 21)+1.082*(administration 25)+1.192 (interpersonal relationship 8). Fifth is the retirement age predictive function of individual sports athlete. The predictive function isY(retirement age)= 27.414-1.295* (job plan 29)+1.463*(physical limitation 15)+0.972* (popularity 1)-0.639*(exercise attitude 16). Sixth is the retirement age predictive function of group sports athlete. The predictive function isY(retirement age)= 21.950+1.950*(popularity 2)-1.318*(exercise attitude 20)+4.635*(interpersonal relationship 6)-3.337*(addiction 41).

Seventh is the retirement age predictive function of undergraduate athlete. The predictive function is Y(retirement age)= 22.186+1.559*(economy 18)-1.889*(economy 16)+1.298*(administration 21)-0.453*(competitiveness 4). Eighth is the retirement age predictive function of unemployed and professional athlete. The predictive function is Y(retirement age)= 27.808 -0.874*(exercise attitude 19)+1.287*(competitiveness 8)-1.402*(administration 21)+0.757*(popularity 2).

When an active athlete is concerned about the time of retirement, expected retirement age of the athlete can be suggested by applying predictor variables of the athlete based on the 5-point scale to the retirement age predictive function of this study. In conducting this study, there was a difficulty in finding retired athletes to collect samples. The regret for not increasing the number of samples further always exists, but this is more so with the questionnaire on retired athletes. The trouble of accurately training past memory would be inversely proportional to the error. Especially, a more reliable and valid retirement age predictive function that can be applied to all affiliations, sex and individual and group sports can be developed by increasing number of samples.

Acknowledgments

This paper was conducted with the support of the National Research Foundation of Korea (2014S1A5B5A02016834).

References

Chae, J. S. & Song, J. K.(2014). Performance Analysis and a Forecasting Model for The Short-Term Series in The Korean Professional Baseball League. *Physical Science Research,* **25(1)**,92-107.

Chae, J. S. & Song, J. K.(2016). Long Term Estimation for the Body Size and BMI of Korean Children & Youth Using ARIMA Model. *Physical Science Research,* **27(3),**530-542.

Chae, J. S. (2012). Prediction Model for Korean Professional Baseball Spectators. *Physical Science Research,* **23(4),** 892-905.

Chae, J. S. Cho, E. H. & Eom, H. J.(2010). Comparisons of the Outcomes of Statistical Models Applied to the Prediction of Post-season Entry in Korean Professional Baseball. *Korean Society of Measurement and Evaluation for Physical Education and Sports Science,* **12(1),** 33-48.

Chae, J. S. Park, J. & So, W. Y.(2018). Ranking prediction model using the competition record of Ladies Professional Golf Association players. *Journal of Strength and Conditioning Research,* **32(8)**:2363-2374.

Chae, J. S. Shin, J. L. & Nam, D. H.(2018). Retrieval of Retirement Factors from Athletes and Validation of Measurement Tools. *Korean Society of Measurement and Evaluation for Physical Education and Sports Science,* **20(2)**, 67-82.

Cho, E. H. & Chae, J. S.(2016). Comparison of the Outcomes of Statistical Models Applied to the Prediction of Play-off Entry in Korean Professional Basketball. *Korean Journal of Physical Education,* **55(1)**, 733-745.

Choi, H. J. & Kim, J. H.(2006). A Study on the Prediction of Game Results in 2005 Wimbledon Tennis Tournament using Artificial Neural Network. *Korean Journal of Physical Education,* **45(3)**, 459-467.

Choi, H. Y. & Jung, Yong Ch(2012). The Narratives of Retired Female Handball Players. *Korean Journal of Physical Education,* **51(6)**, 83-93.

Chung, J. H.(2010). In Research of Women's National Basketball Team Players' Perception of Retirement. *Physical Science Research,* **21(1)**, 1051-1062.

Coakley, J. J.(1983). Leaving Competitive Sport : Retirement or Rebirth? *Quest,* **35**, 1-11.

Eitzen, D. S. & Sage, G. H. (1993). Sociology of North American Sport, 5th ed. Madison, WI: Brown & Benchmark. Empirical Considerations. *Sociology* *of Sport Journal,* **2**, 101-110.

Han, S. D.(1999). A study for retirement attitude and retirement readiness programs for professional football players. *Korean Journal of Physical Education,* **38(4)**,172-184.

Hong, S. H(2010). The Relationship between the Attributes, Athletic Career and Retirement of Professional Players. *Korean Journal of Social Sports,* **39**, 943-951.

Jang, S. H. & Kim, I. H.(2016). Retirement Circumstances and Social Adaptation Experience in the Re-socialization Process of Badminton Players. *Korean Journal of Physical Education,* **55(5).** 29-41.

Kerr, G., & Dacyshyn, A.(2000). The retirement experience of elite, female gymnasts. *Journal of Applied Sport Psychology,* **12,** 115-133.

Kim, C. Y.(2001). Win / loss prediction model through professional baseball game analysis. Korean *Journal of Social Sports*, 807-819.

Kim, J. H. No, G, T. Park, J, S. & Lee, W, H.(2007). The Development of Soccer Game WinLost Prediction Model Using Neural Network Analysis - FIFA world cup 2006 Germany. *Korean Journal of Sport Science,* **18(4)**,54-63.

Kim, O. C. & Lim, S, W.(1999).Probability of Athlete Achievement and Retirement. *Korean Journal of Sports Sociology,* **12**,141-160.

Kim, T. W. & Chae, J. S.(2017). Comparison of National Competitions of Women's Curling Competition and Prediction of Win-loss. *Korean Journal of Physical Education,* **56(4)**, 595-604.

Lee, S. B. & Cho, M. H.(2012). A Study on Social Adjustment after Judo Retirement. *Journal of Sport Science,* **24(1)**,89-105.

Lerch, S. H.(1984). The Adjustment of Retirement of Professional Baseball Players. In S. L. Greendorfer & A. Yiannakis (Eds), Sociology of Sport : Diverse Perspectives. West Point, NY : Leisure Press, 138-148.

McKenna, J. & Thomas, H.(2007). Enduring injustice: A case study of retirement from professional rugby union. *sport, Education, and Society,* **12**, 19-35.

Park, D. J. & Won, Y. S.(2014). Career Transition Process of Former Korean National Ice Hockey Players. *Korean Journal of Sports Sociology,* **27(2)**, 27-53.

Seo, Y. H.(2012). The Structural Relationship among Athlete's Retirement Expectation, Psychological Sense of Crisis, Level of Retirement Preparation and Re-socialization. *Korean Journal of Athletic Science,* **21(4)**,393-406.

Sung, B. J. & Ko, B. G.(2017). A study on regression equation of physical fitness age for korean men and women adult. *Korean Society of Measurement and Evaluation for Physical Education and Sports Science,* **19(2)**, 59~82.

Dong-A Daily (2015)

http://news.naver.com/main/read.nhn?mode=LSD&mid=sec&sid1=001&oid=020&aid=0002776732

Job Korea(2017). http://www.hansunkyo.com/mediacenter/data_view.asp?id=33831