Write your name here

Surname	Other names

Pearson Edexcel Level 3 Certificate

Centre Number | | | | | |

Candidate Number | | | | |

Mathematics in Context

Paper 1: Comprehension

Wednesday 16 May 2018 – Morning
Time: 1 hour 40 minutes

Paper Reference
7MC0/01

You must have: Ruler graduated in centimetres and millimetres, pen, HB pencil, eraser, calculator. Source booklet.

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided
  – *there may be more space than you need.*
- **Calculators may be used.**

Information

- The total mark for this paper is 60
- The marks for **each** question are shown in brackets
  – *use this as a guide as to how much time to spend on each question.*

Advice

- Read each question carefully before you start to answer it.
- Keep an eye on the time.
- Try to answer every question.
- Check your answers if you have time at the end.

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SECTION A

Answer ALL questions. Write your answers in the spaces provided.

OBESITY

Refer to **data source A** in the source booklet for Questions 1 and 2.

1 Use the information in data source A to

(a) (i) work out the expected increase in the average (median) age of the population in the UK from 2012 to 2037,

(1)

(ii) work out the expected percentage increase in the average (median) age of the population in the UK from 2012 to 2037.

(1)

(b) Write down **two** comments comparing the distribution of the ages of females in the UK with the distribution of the ages of males in the UK.

Use the population pyramid for the UK as at the 2011 census to support your statements.

(2)

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(Total for Question 1 is 4 marks)

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2 (i) Use the figures given in Table 1 in the source booklet to complete this table.

(3)

Age (years)	Percentage of the population	Cumulative percentage
0–9	11.8	11.8
10–19	12.1	23.9
20–29	13.6	37.5
30–39	13.1	
40–49	14.6	
50–59	12.2	
60–69	10.8	
70–79		
80–89		
90+	0.8	

(ii) Use the information in your completed table to draw a suitable graph to show the cumulative percentages.

(3)

(iii) State any assumptions you make to complete your graph.

(1)

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(iv) Estimate the percentage of the population aged 65 years or older.

(2)

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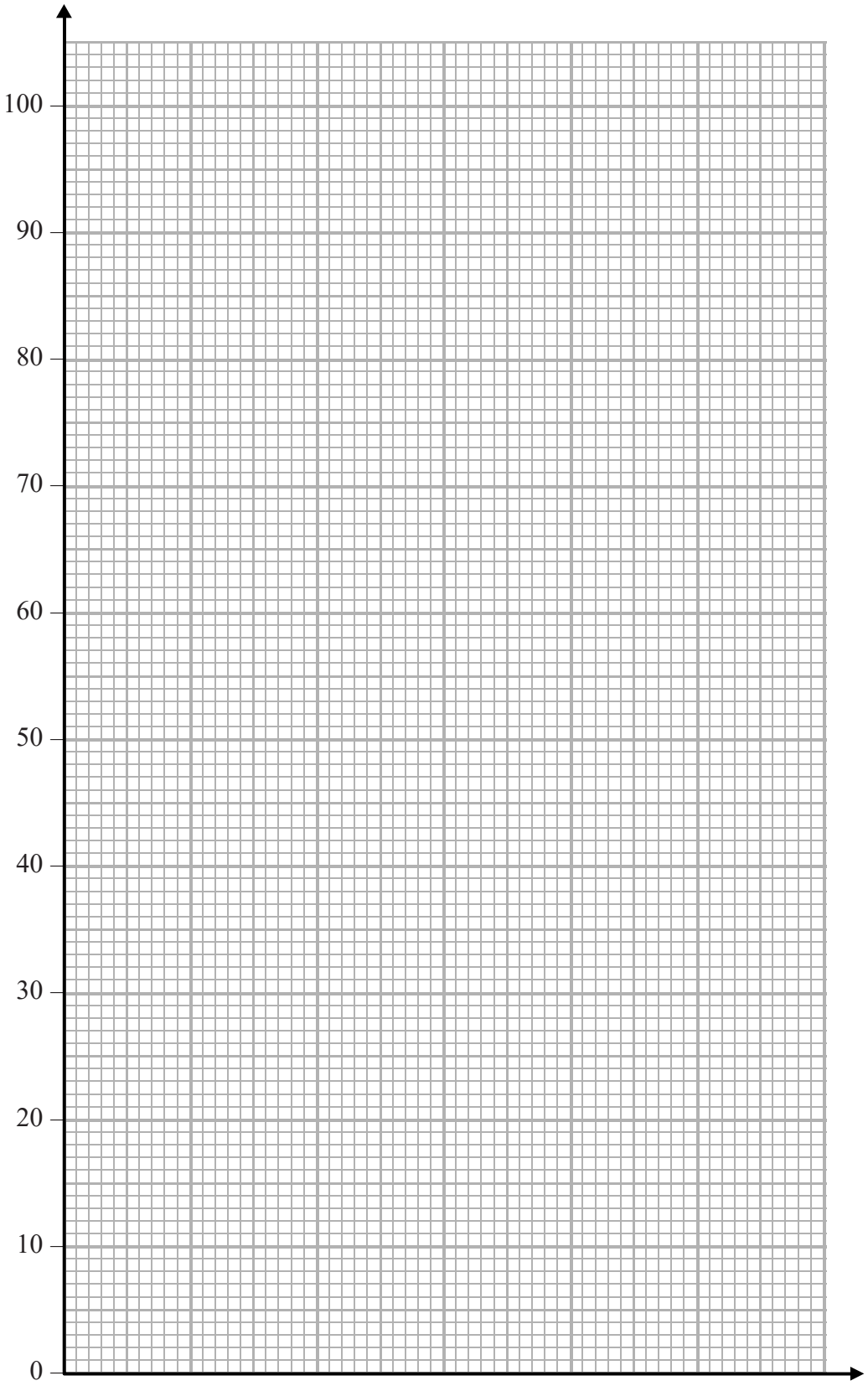


(Total for Question 2 is 9 marks)

Refer to **data sources A and B** in the source booklet.

3 (a) For the UK population, work out an estimate for the number of children aged 5–9 who are obese and the number of adults aged 60–64 who are obese.

(3)

There is the same percentage, to the nearest whole number, of the UK population in the age groups 5–9 years and 60–64 years.

A child is picked at random from the age group 5–9 and an adult is picked at random from the age group 60–64.

(b) Is the probability that the child is obese the same as the probability that the adult is obese? Give a reason for your answer.

(1)

(Total for Question 3 is 4 marks)

Refer to **data source B** in the source booklet for Questions 4 and 5.

4 Use the figures in data source B to estimate the population of the planet in 2013

(Total for Question 4 is 2 marks)

5 Is it true that more men are overweight or obese in Iceland than in the UK?
Justify your answer.

(Total for Question 5 is 1 mark)

Refer to **data source C** in the source booklet.

6 Samantha is 1.6 m tall.
She is in the normal weight category.

Calculate her least possible weight and her greatest possible weight.

(Total for Question 6 is 3 marks)

Refer to **data source D** in the source booklet.

7 A recent article in Canada asks

"Do people in richer countries just eat more?"

(i) Calculate the Spearman's rank correlation coefficient, using the data in data source D, to help answer this question.

(6)

Country	GDP per capita (US $)	Percentage of population with BMI $\geqslant$ 30		
United States	45 674	27.5		
Greece	29 268	18.1		
Estonia	19 880	18.0		
Czech Republic	25 530	17.1		
Canada	37 808	15.9		
Finland	35 237	15.7		
Turkey	14 243	15.2		
Belgium	36 308	13.8		
Israel	27 661	13.6		
France	33 698	11.2		
Netherlands	40 813	11.1		
Norway	55 750	10.0		
Sweden	36 996	10.0		
Italy	32 408	9.9		

(ii) Without doing any further calculation, what effect would removing the data for Norway have on the Spearman's rank correlation coefficient?
Give a reason for your answer.

(1)

(Total for Question 7 is 7 marks)

(Total for OBESITY is 30 marks)

TOTAL FOR SECTION A IS 30 MARKS

SECTION B

Answer ALL questions. Write your answers in the spaces provided.

FORMULA 1 RACING

Refer to **data source E** in the source booklet for Questions 8, 9, 10 and 11.

The article states that Hamilton finished the race 76 points clear of his nearest rival with a maximum of 75 points still available for any driver.

8 (a) When this article was written, how many races were left in the 2015 Grand Prix season?

(1)

.....

.....

A spreadsheet can be used to calculate the total points scored by a driver in any season.

	A	B	C	D
1	**Race position**	**Number of races**	**Points per race**	**Total points**
2	1	10	25	
3	2	3	18	
4	3	1	15	
5	4	0	12	
6	5	0	10	
7	6	1	8	
8	7	0	6	
9	8	0	4	
10	9	0	2	
11	10	0	1	
12		Total points for the season		

Spreadsheet of results for Lewis Hamilton 2015 season

(b) (i) Write down a suitable formula for cell D2

(2)

.....

.....

(ii) Write down a suitable formula for cell D12

(2)

.....

(Total for Question 8 is 5 marks)

9 (a) Calculate the mean and standard deviation for the fastest lap times for 2015

$$\Sigma t = 1673.355 \qquad \Sigma t^2 = 158\,092.185$$

where t seconds is the fastest lap time in 2015 for the 18 countries.

(3)

For the fastest lap times in 2014

the mean is 1 minute 34.154 seconds
and the standard deviation is 12.282 seconds.

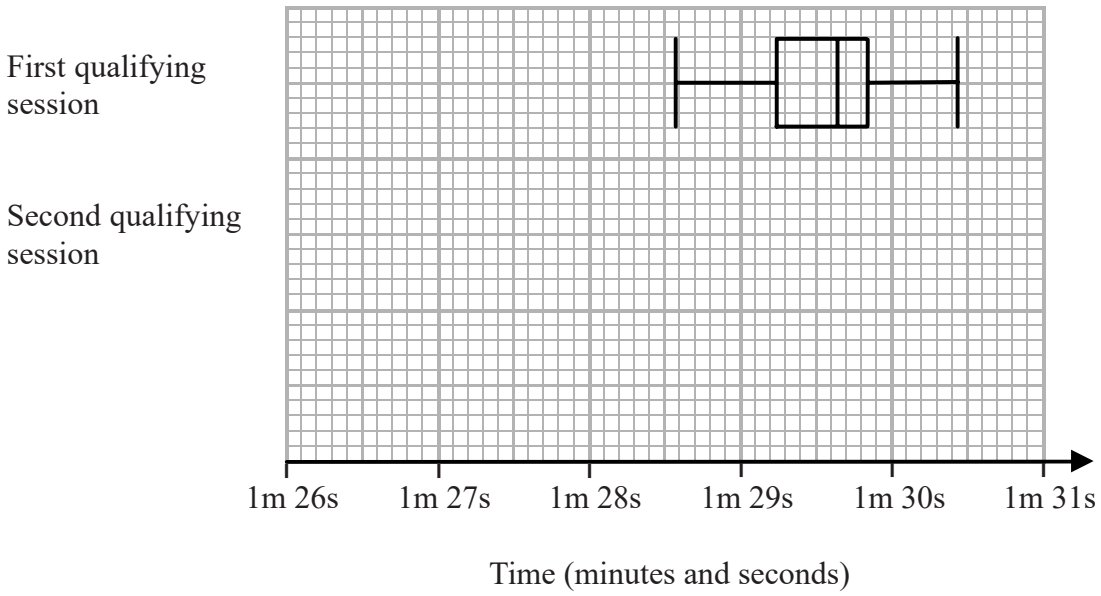
(b) Compare and interpret, in context, the figures for 2014 with the figures for 2015

(3)

(Total for Question 9 is 6 marks)

10 There were three qualifying sessions at the Australian Grand Prix.

The data for the fastest lap time for each driver for the first qualifying session is summarised in the box plot.



The table below gives information about the fastest lap time for each driver for the second qualifying session.

Driver	Second qualifying session (minutes and seconds)
Lewis Hamilton	1:26.894
Nico Rosberg	1:27.097
Sebastian Vettel	1:27.742
Valtteri Bottas	1:27.796
Kimi Räikkönen	1:27.807
Felipe Massa	1:27.895
Romain Grosjean	1:28.589
Carlos Sainz	1:28.601
Daniel Ricciardo	1:28.679
Pastor Maldonado	1:28.726
Felipe Nasr	1:28.800
Max Verstappen	1:28.868
Daniil Kvyat	1:29.070
Nico Hulkenberg	1:29.208
Sergio Perez	1:29.209

An outlier is defined as any value that is

greater than the upper quartile + (1.5 × interquartile range)

or

less than the lower quartile − (1.5 × interquartile range)

(a) (i) Using the data for the fastest lap time for each driver for the second qualifying session, show there are no outliers.

(3)

(ii) On the grid opposite, draw a box plot to summarise the data for the second qualifying session.

(3)

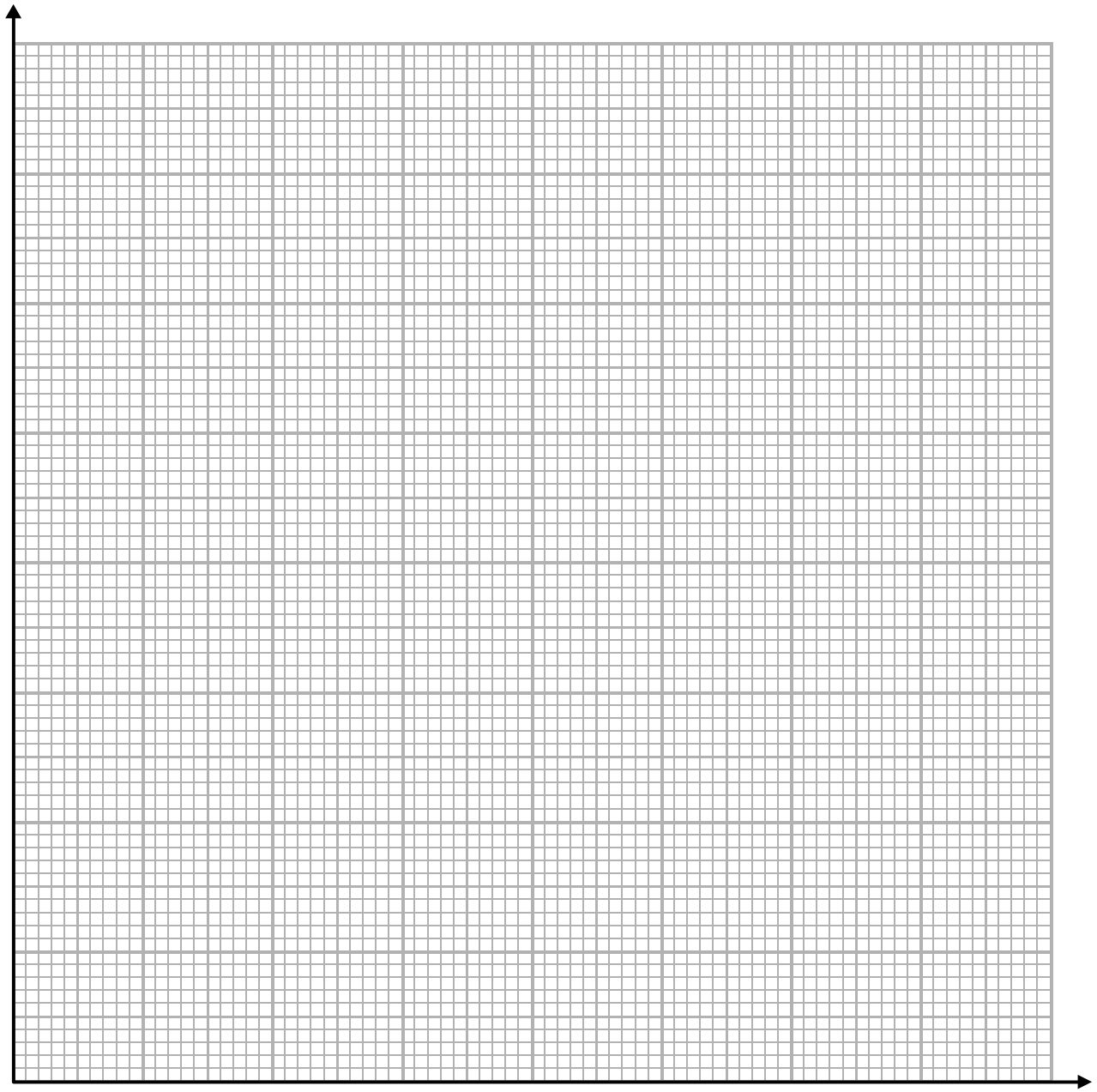
(b) Use the box plots to compare the two distributions.

(2)

(Total for Question 10 is 8 marks)

11 (a) Using the information in Table 6 in the source booklet, draw an appropriate diagram on the graph paper below to determine the nature of the correlation between the lap length and the fastest lap time in 2015.

(4)



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Mexico has a race circuit with a lap length of 4.313 km.

(b) Use your diagram to estimate the fastest lap time you would expect for this circuit. Comment on the reliability of your estimate.

(2)

Given that $\Sigma x = 93.534$, $\Sigma t = 1673.355$, $\Sigma xt = 8831.576$, $\Sigma x^2 = 498.090$, $\Sigma t^2 = 158\,092.185$

(c) calculate the product moment correlation coefficient between the lap length (x km) and the fastest lap time in 2015 (t seconds).

Give your answer correct to 2 decimal places.

(3)

(d) Interpret your answer to part (c).

(2)

(Total for Question 11 is 11 marks)

(Total for FORMULA 1 RACING is 30 marks)

TOTAL FOR SECTION B IS 30 MARKS
TOTAL FOR PAPER IS 60 MARKS

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Pearson Edexcel Level 3 Certificate

Mathematics in Context

Paper 1: Comprehension

Wednesday 16 May 2018 – Morning
Source booklet

Paper Reference
7MC0/01

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Formulae sheet

There will be no credit for anything you write on this formulae sheet.

Mean of a frequency distribution $= \dfrac{\sum fx}{\sum f}$

Mean of a grouped frequency distribution $= \dfrac{\sum fx}{\sum f}$, where x is the mid-interval value

Variance $= \dfrac{\sum (x - \bar{x})^2}{n}$

Standard deviation (set of numbers) $\sqrt{\left[\dfrac{\sum x^2}{n} - \left(\dfrac{\sum x}{n}\right)^2\right]}$

or $\sqrt{\left[\dfrac{\sum (x - \bar{x})^2}{n}\right]}$

where $\bar{x}$ is the mean of the set of values

Standard deviation
(discrete frequency distribution) $\sqrt{\left[\dfrac{\sum fx^2}{\sum f} - \left(\dfrac{\sum fx}{\sum f}\right)^2\right]}$

or $\sqrt{\left[\dfrac{\sum f(x - \bar{x})^2}{\sum f}\right]}$

Spearman's rank correlation coefficient $1 - \dfrac{6\sum d^2}{n(n^2 - 1)}$

The product moment correlation coefficient is

$$r = \frac{S_{xy}}{\sqrt{S_{xx}S_{yy}}} = \frac{\sum x_i y_i - \frac{\left(\sum x_i\right)\left(\sum y_i\right)}{n}}{\sqrt{\left(\sum x_i^2 - \frac{\left(\sum x_i\right)^2}{n}\right)\left(\sum y_i^2 - \frac{\left(\sum y_i\right)^2}{n}\right)}}$$

The regression coefficient of y on x is $b = \frac{S_{xy}}{S_{xx}}$

Least squares regression line of y on x is $y = a + bx$ where $a = \bar{y} - b\bar{x}$

Arithmetic series

$$u_n = a + (n - 1)d$$

$$S_n = \frac{1}{2}n(a + l) = \frac{1}{2}n[2a + (n - 1)d]$$

Geometric series

$$u_n = ar^{n-1}$$

$$S_n = \frac{a(1 - r^n)}{1 - r}$$

$$S_\infty = \frac{a}{1 - r} \quad \text{for } |r| < 1$$

There will be no credit for anything you write in this source booklet.

SECTION A: OBESITY

Data source A

The UK Office for National Statistics' 2012-based National Population Projections suggest that the average (median) age of the population would rise from 39.7 in 2012 to 42.8 in 2037 if current demographic trends continued. More recent estimates for mid-2014 suggest the median age of the UK population was at its highest ever at 40 years.

Population pyramid for the United Kingdom as at the 2011 census

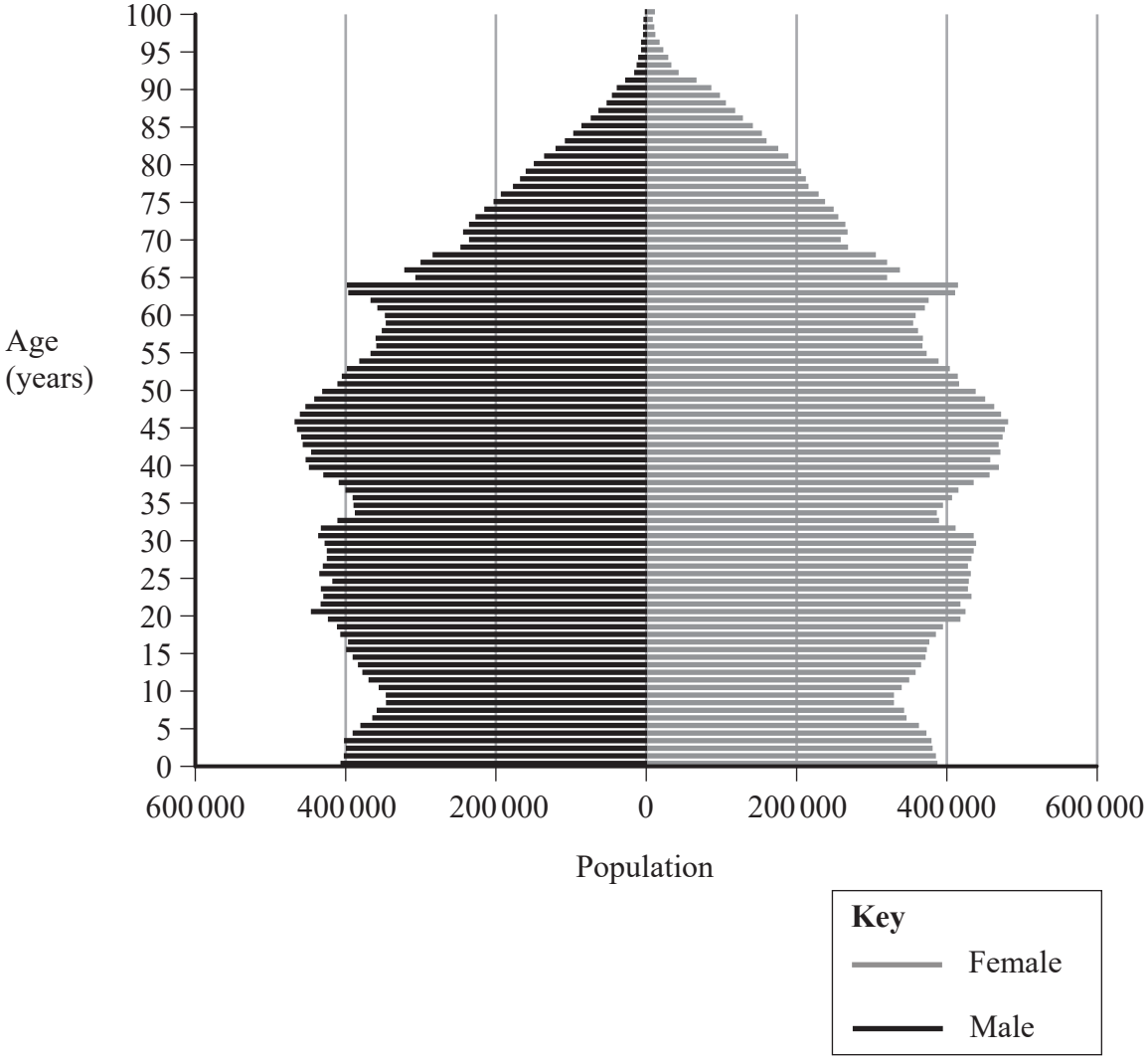

Table 1: Age structure for UK population as at the 2011 census

Age (years)	Population	% of total
0 – 4	3 914 000	6.2
5 – 9	3 517 000	5.6
10 – 14	3 670 000	5.8
15 – 19	3 997 000	6.3
20 – 24	4 297 000	6.8
25 – 29	4 307 000	6.8
30 – 34	4 126 000	6.5
35 – 39	4 194 000	6.6
40 – 44	4 626 000	7.3
45 – 49	4 643 000	7.3
50 – 54	4 095 000	6.5
55 – 59	3 614 000	5.7
60 – 64	3 807 000	6.0
65 – 69	3 017 000	4.8
70 – 74	2 463 000	3.9
75 – 79	2 006 000	3.2
80 – 84	1 496 000	2.4
85 – 89	918 000	1.5
90+	476 000	0.8

Data source B

UK among worst in western Europe for level of overweight and obese people

Only Iceland and Malta have higher proportion of people who are overweight or obese, study finds.

The Global Burden of Disease study, published in the Lancet medical journal, which uses data from 1980 to 2013, found that the number of overweight and obese people in the world had surged in the past three decades. About 2.1 billion people – nearly 30% of the population of the planet – are overweight or obese, raising the risk of diabetes, heart disease and cancers. Although the rise in obesity rates seems to be slowing in some countries, it has yet to be reversed in any.

"Obesity is an issue affecting people of all ages and incomes, everywhere," said Dr Christopher Murray, director of the Institute of Health Metrics and Evaluation (IHME) in Seattle and a co-founder of the Global Burden of Disease study.

"In the last three decades, not one country has achieved success in reducing obesity rates, and we expect obesity to rise steadily as incomes rise in low- and middle-income countries in particular, unless urgent steps are taken to address this public health crisis."

In western Europe, the UK lags behind only Iceland, with 74% of men and 61% of women overweight or obese, and Malta, with 74% and 58% respectively.

Table 2a: Top 5 countries for overweight or obese men, aged 20+

Country	Men (%)
Malta	74.0
Iceland	73.6
Greece	71.4
Cyprus	67.8
UK	66.6

Table 2b: Top 5 countries for overweight or obese women, aged 20+

Country	Women (%)
Malta	57.8
Iceland	60.9
UK	57.2
Portugal	54.6
Israel	52.7

Obesity alone increased by 10% in the UK over the past three decades, the study finds. There was a slight drop in the numbers of obese people between 1980 and 1986, before it began to rise steadily. About a quarter of the UK population is now obese. The peak age for children is at 5–9, when about 10% are obese. Among adults, it is at 60–64, when a third of men and women are obese. "Despite the significant advancements that the United Kingdom has made in public health over the last 30 years, we have not been immune to this global trend," said Dr Ivy Shiue, assistant professor at Heriot-Watt University, Edinburgh, and an author of the study. "The rapid increase in child obesity is particularly disturbing, as being overweight at a young age can set children up for a lifetime of poor health."

Data source C

In this article it shows you how to calculate your BMI and how to find your weight category. BMI is a measurement which determines which weight category a person belongs to. Depending on their height and weight, a person can belong to one of the following weight categories:

- underweight (BMI less than 18.5)
- normal weight ($18.5 \leqslant \text{BMI} < 25.0$)
- overweight ($25.0 \leqslant \text{BMI} < 30.0$)
- obese (BMI 30.0 and above)

$$\text{BMI} = \frac{(\text{weight in kilograms})}{(\text{height in metres})^2}$$

Data source D

Obesity and GDP: Do people in richer countries just eat more?

Statistics Canada Daily has just reported on an article on the prevalence of adult obesity in Canada and the United States. In the United States, the National Health and Nutrition Examination Survey (NHANES) has been gathering measured height and weight data for years. In 2007, the Canadian Health Measures Survey (CHMS) began collecting direct measurements of height, weight, body mass index (BMI), skinfolds and waist circumference from a nationally representative sample of the population. The nature of these surveys has created an opportunity to compare rates of obesity among adults in Canada and the United States. The results show that from 2007 to 2009, the prevalence of obesity (defined as a BMI of 30 or greater) in Canada was 24.1%, over 10 percentage points lower than in the United States (34.4%). Among men, the prevalence of obesity was over 8 percentage points lower in Canada than in the United States (24.3% compared with 32.6%) and among women, more than 12 percentage points lower (23.9% compared with 36.2%).

The interesting question is what may account for the difference? Is it lifestyle? Cultural preferences? Given the similarities between Canada and the United States, it is difficult to see what major cultural or lifestyle differences could account for such a difference. One major difference between the two countries is economic – the difference in GDP per capita. It could be differences in the material standard of living, as captured by GDP, affect the resources available for food consumption. Moreover, income and education are also correlated and it could be that countries with higher incomes have better educated populations and therefore are more knowledgeable about health and food consumption, meaning the relationship between BMI and income could be negative rather than positive.

The GDP (Gross Domestic Product) for each country is the total value, in dollars, of all the transactions (goods and services) in one year.

The GDP per capita is the GDP for that country divided by the population of that country.

Table 3: GDP per capita (US $) and the percentage of population with BMI $\geqslant 30$

Country	GDP per capita (US $)	Percentage of population with BMI $\geqslant$ 30
United States	45 674	27.5
Greece	29 268	18.1
Estonia	19 880	18.0
Czech Republic	25 530	17.1
Canada	37 808	15.9
Finland	35 237	15.7
Turkey	14 243	15.2
Belgium	36 308	13.8
Israel	27 661	13.6
France	33 698	11.2
Netherlands	40 813	11.1
Norway	55 750	10.0
Sweden	36 996	10.0
Italy	32 408	9.9

SECTION B: FORMULA 1 RACING

Data source E

October 2015

After the ecstatic Lewis Hamilton took the chequered flag on Sunday he performed donut spins for the cheering crowd while Daft Punk's "One More Time" blared out from the Mercedes garage. As he crossed the line and had it confirmed that he had equalled his idol Ayrton Senna with his third F1 world title, the 30-year-old said over the car radio: "This is the greatest moment of my life."

A little later tears mixed with sprayed champagne. Beside Hamilton and his beaten team-mate Nico Rosberg and Ferrari's Sebastian Vettel on the podium there was Sir Elton John. It is not often that he looks upstaged.

Hamilton needed to beat his closest challenger, Vettel, by nine points and Mercedes team-mate Rosberg by two, and he did just that – finishing the race 76 points clear of his nearest rival, with 75 points still available. Rosberg was second and Vettel, who needed to be runner-up if Hamilton won to push the championship into next weekend's race in Mexico, was third.

Even as he approached the winning line Hamilton could not be certain he had won the championship because Vettel continued to put Rosberg under intense pressure until the end. It was Hamilton's third win in the four races in Austin as he secured the title.

The rain which had blighted much of the weekend in Texas finally relented. But its legacy was a damp and occasionally wet track which made this the busiest, most unpredictable of races. The rain had forced the cancellation of qualifying on Saturday and curtailed it on Sunday morning, with grid positions decided by Q2 (second qualification session). All the cars started on intermediate tyres.

The only predictable thing was the start. Hamilton, who was second on the grid, went straight on the attack and was level with the pole-sitter Rosberg almost immediately. Then, as they went into turn one, Hamilton, on the inside, squeezed his team-mate wide. Rosberg would not yield and the two touched wheels but it was Hamilton's racing line and the German was forced out, dropping to fourth behind Kvyat and Daniel Ricciardo.

It was yet another example of Rosberg's inability to beat Hamilton in wheel-to-wheel racing. He knew he could not afford to finish second to Hamilton in this race but he could not do anything about it.

Vettel, who had started back in 14th place because of a 10-place grid penalty, refused to let himself drift out of the championship picture and steadily worked his way through the field.

The Englishman's 10th win of the season put him alongside Sir Jackie Stewart with three titles but he is the first British driver to successfully defend his championship.

Table 4: 2015 Australian Grand Prix qualifying times

		Fastest lap time (minutes and seconds)		
Driver	**Team**	**Q1**	**Q2**	**Q3**
Lewis Hamilton	Mercedes	1:28.586	1:26.894	1:26.327
Nico Rosberg	Mercedes	1:28.906	1:27.097	1:26.921
Felipe Massa	Williams	1:29.246	1:27.895	1:27.718
Sebastian Vettel	Ferrari	1:29.307	1:27.742	1:27.757
Kimi Räikkönen	Ferrari	1:29.754	1:27.807	1:27.790
Valtteri Bottas	Williams	1:29.641	1:27.796	1:28.087
Daniel Ricciardo	Red Bull Racing	1:29.788	1:28.679	1:28.329
Carlos Sainz	Toro Rosso	1:29.597	1:28.601	1:28.510
Romain Grosjean	Lotus	1:29.537	1:28.589	1:28.560
Pastor Maldonado	Lotus	1:29.847	1:28.726	1:29.480
Felipe Nasr	Sauber	1:30.430	1:28.800	
Max Verstappen	Toro Rosso	1:29.248	1:28.868	
Daniil Kvyat	Red Bull Racing	1:30.402	1:29.070	
Nico Hulkenberg	Force India	1:29.651	1:29.208	
Sergio Perez	Force India	1:29.990	1:29.209	

Key **Q1** First qualifying session
Q2 Second qualifying session
Q3 Third qualifying session

In the Formula 1 World Championship, drivers take part in a number of Grand Prix races. The first ten drivers in each race get points depending on their end of race position. Their points from each race are added up. The driver with the most points at the end of the season wins the World Championship.

Table 5: Grand Prix championship points awarded for end of race position

Race position	Championship points
1	25
2	18
3	15
4	12
5	10
6	8
7	6
8	4
9	2
10	1

Table 6: Grand Prix circuit lap length and fastest lap times for 2014 and 2015 seasons for 18 countries

Country	Lap length (km)	Fastest lap time (minutes and seconds) 2014	Fastest lap time (minutes and seconds) 2015
Australia	5.303	1:32.478	1:30.945
Malaysia	5.543	1:43.066	1:42.062
China	5.451	1:40.402	1:42.208
Bahrain	5.412	1:37.020	1:36.311
Spain	4.655	1:28.918	1:28.270
Monaco	3.337	1:18.479	1:18.063
Canada	4.361	1:18.504	1:16.987
Austria	4.326	1:12.142	1:11.235
Great Britain	5.891	1:37.176	1:37.093
Hungary	4.381	1:25.724	1:24.821
Belgium	7.004	1:50.511	1:52.416
Italy	5.793	1:28.004	1:26.672
Singapore	5.065	1:50.417	1:50.041
Japan	5.807	1:51.600	1:36.145
Russia	5.872	1:40.896	1:40.071
United States	5.470	1:41.379	1:40.666
Brazil	4.309	1:13.555	1:14.832
Abu Dhabi	5.554	1:44.496	1:44.517

Source information

http://www.theguardian.com/society/2014/may/29/uk-western-europe-obesity-study
https://en.wikipedia.org/wiki/Demography_of_the_United_Kingdom#UK_population_change_over_time
http://www.whathealth.com/bmi/formula.html
http://ldimatte.shawwebspace.ca/blog/post/obesity_and_gdp__do_richer_count
http://www.theguardian.com/sport/2015/oct/25/lewis-hamilton-wins-f1-world-title-third-time-us-grand-prix
http://www.formula1.com/content/fom-website/en/championship/results/dhl-fastest-lap-2014.html
https://en.wikipedia.org/wiki/List_of_Formula_One_circuits