

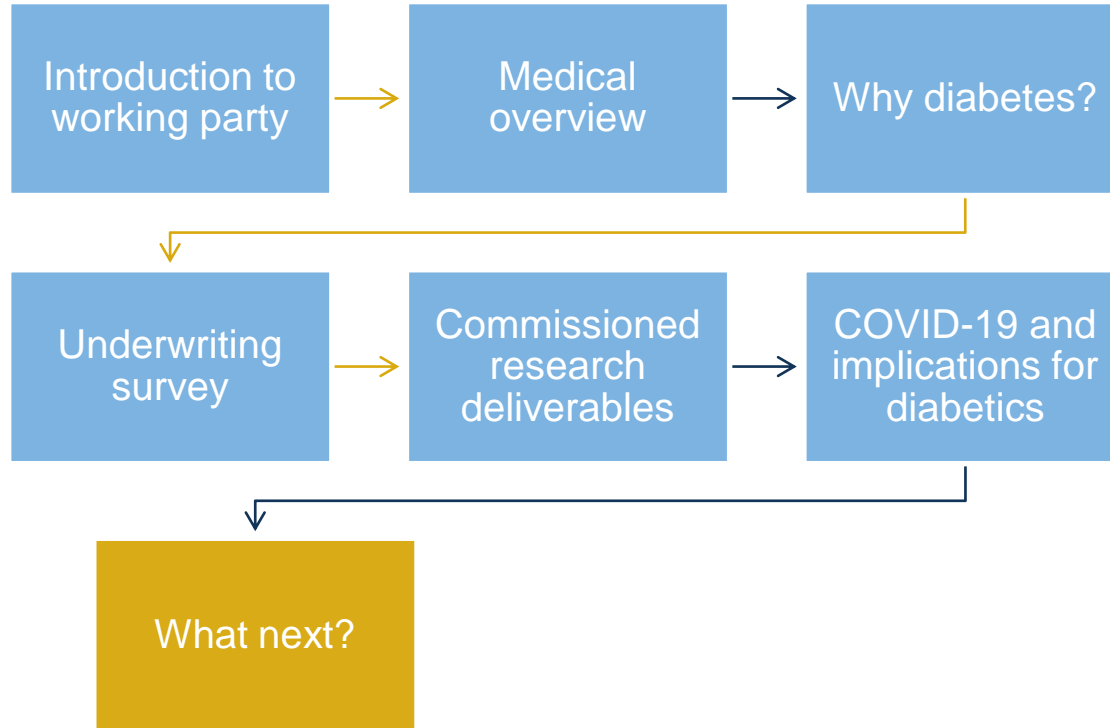


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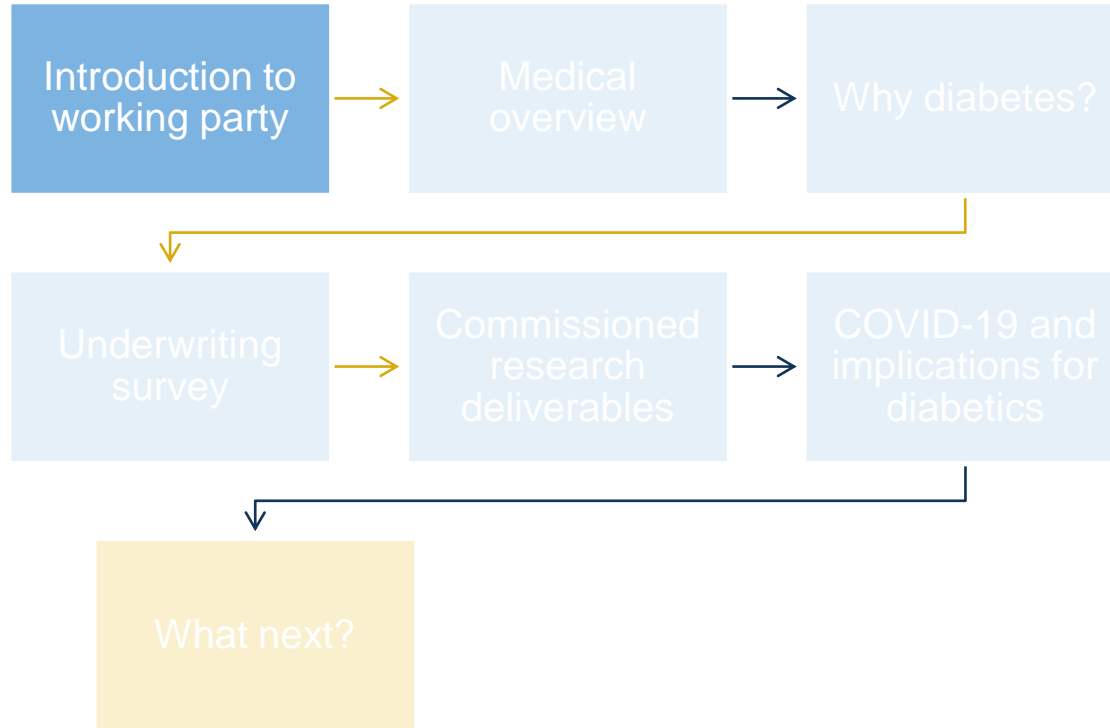
# Can we manage Diabetes risk for healthier outcomes?

Nicola Oliver, Medical Intelligence  
Scott Reid, Zurich

# Agenda



# Agenda

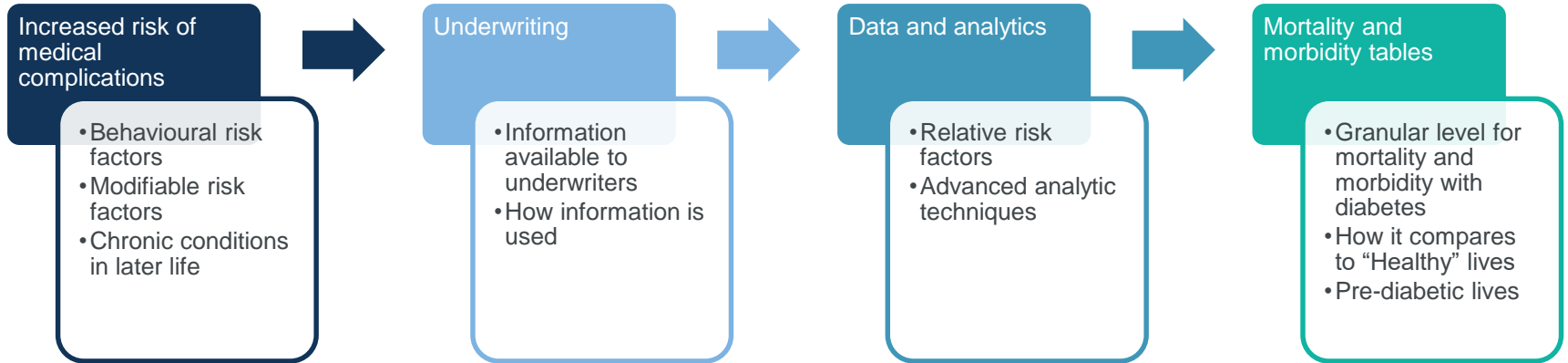


# Introduction to Working Party

- Practice area – Health and Care, IFoA
- Established in 2018
- Previous IFoA research
  - JIA 75 (1949) 0094-0100, An Investigation into the mortality of diabetic patients attending the diabetic clinic of King's College Hospital, Arthur James Steed, FIA
  - JIA 91 (1965) 286-336, An Investigation into the mortality of diabetes, R E Hayward, FIA and B C Lucena, FFA
  - JIA (1974) 101:405-413, B H Shaw
- More recent IFoA research
  - Impactability modelling: A worked example in type II diabetes (2019, Hot topics in Health and Care)
  - The Impact of Diabetes Mellitus II on Longevity and Morbidity Risk (2018/2019, Njabulo Ncube, UEA (UK))

# Objectives of the research

Develop a deeper understanding of the risks associated with a diagnosis of type 1 or type 2 diabetes and the impact of recent improved treatments



# Working Party Members

Name of members	Role	Firm	Location	Occupation
Nicola Oliver	Chair / SG Chair	Medical Intelligence	UK/France	Medical
Scott Reid	Deputy Chair / SG member	Zurich / Switzerland	UK/Switzerland	Actuary
Ian Catchpole	SG Deputy Chair	Aviva	UK	Actuary
Constantinos Rossides		Deloitte	Cyprus	Actuary
Jon Lambert		Swiss Re	UK	Medical Underwriter
Matthias Schneider	Workstream co-ordinator	Zurich / Germany	Germany	Risk Management
Peter Chadwick		Aviva	UK	Actuary
Chris Bagnall		Zurich / Switzerland	Switzerland	Medical Underwriter
Han Yan		Canada Life	UK	Actuary
Ivy Tang		Future InsurBay	China	Actuary
Sol Jiarong		Swiss Re	China	Actuary
Joey Zhou	Workstream co-ordinator	RGA	Singapore	Actuary
Roshan Tajapra		SCOR	UK	Actuary
Samuel Lim		Gen Re	Singapore	Actuary
Brian Cunningham		Aviva	Ireland	Actuary
Health & Care Research shadow	Role	Firm	Location	Occupation
Ewen Tweedie	Shadow H&C Research comm	PwC	UK	Actuary

Consultants to WP	University	Role
Professor Neil Munro	University of Surrey	Academic
Professor Kamlesh Khuni	University Leicester	Clinician and Academic
Professor Simon Lusignan	University Surrey	Clinician and Academic



# Steering Group commissioning partners

## Purpose and membership

- To oversee delivery and quality assurance of this commissioned research
- To ensure research outputs that are of a high quality and in line with expectations, producing findings that are relevant to the actuarial community, industry and other key stakeholder groups
- Group comprises of:
  - 2 IFoA members (Chair and member of Diabetes Working party)
  - 4 representatives for each commissioning partner
  - 1 independent Academic
  - 2 IFoA Executive – Research Project Manager, ARC Manager – non-voting members

## Commissioning partners



Swiss Re



PartnerRe



Actuarial  
Research Centre  
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## Independent academic guidance

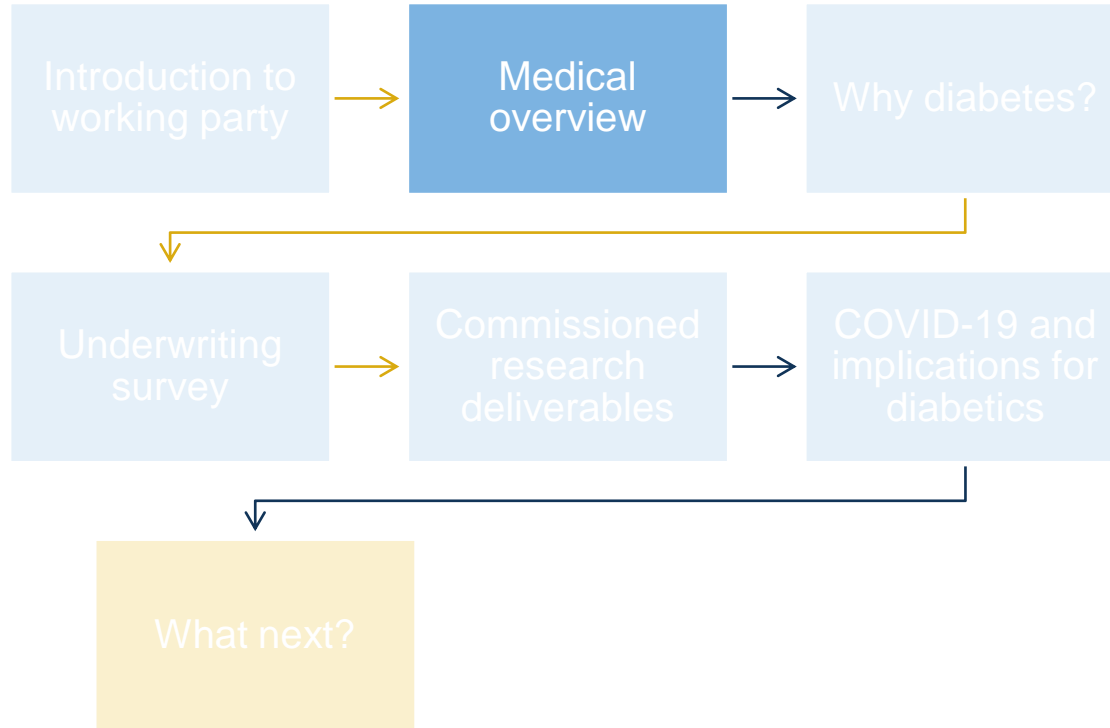


Cass Business School  
CITY UNIVERSITY LONDON



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# Agenda







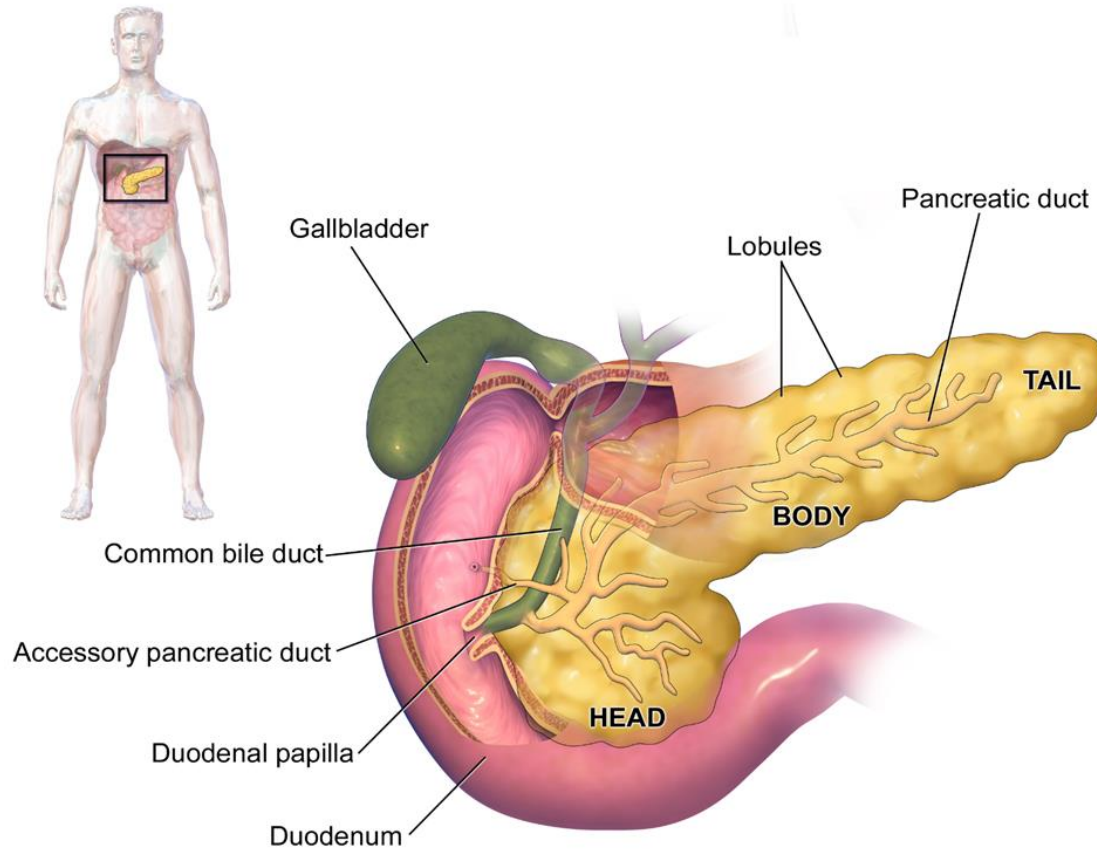
World Health  
Organization

“The term **diabetes mellitus** describes a metabolic disorder of multiple aetiology characterized by chronic **hyperglycaemia** with disturbances of carbohydrate, fat and protein metabolism resulting from **defects in insulin secretion**, insulin **action**, or both. The effects of diabetes mellitus include **long-term damage, dysfunction and failure of various organs.**”

**Inability to  
produce or  
respond to  
insulin**

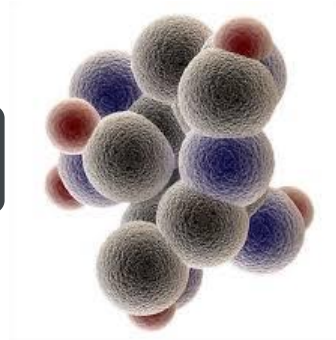


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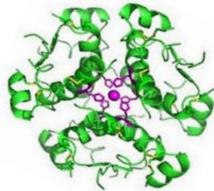




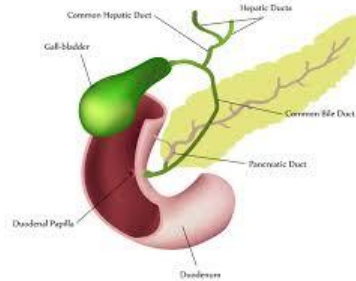
converted



circulation



insulin

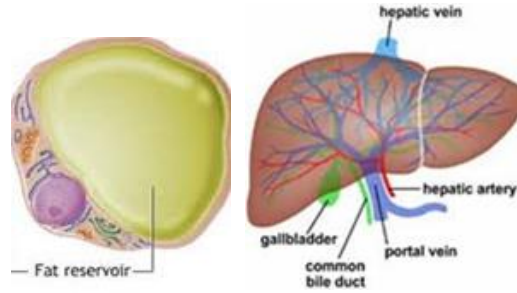


Beta cells

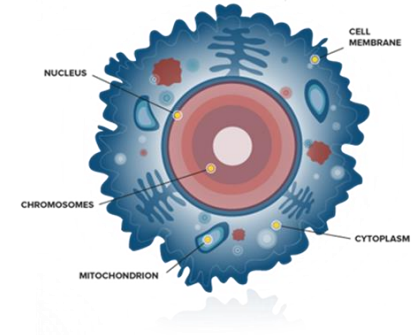




Excess



Glycogen



Glucagon





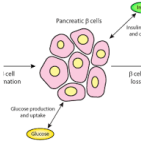
# Type 1 Diabetes

Insulin Dependent



Develops in young lives

Chronic autoimmune disease caused by destruction of the beta-cells



Requires life-long treatment with insulin



# Type 2 Diabetes

Non-insulin dependent (can progress)



Usually develops in older lives

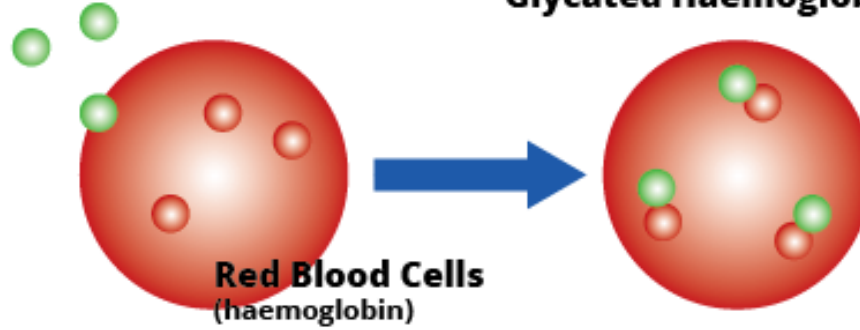
Insulin resistance related to lifestyle factors



Often treated with oral meds

**Sugar (glucose)**

**Glycated Haemoglobin (HbA1c)**



Red blood cell lifespan 120 days

Glucose covalently bound to hemoglobin

Bonding is known as glycation

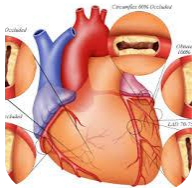
'glycated hemoglobin'

**HbA1c**

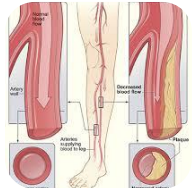


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# Macrovascular Complications



Coronary artery disease

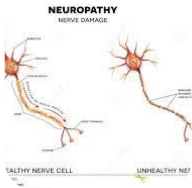


Peripheral arterial disease

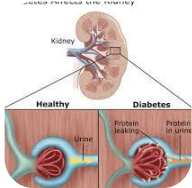


Stroke

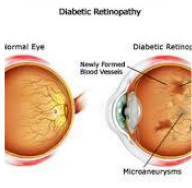
# Microvascular Complications



Neuropathy



Nephropathy



Retinopathy



Literature review

16 papers

Mortality and  
diabetes

Published 2009-2018

Search terms

Excess mortality evident in  
those with diabetes vs.  
those without

**“diabetes” “survival” “mortality” “life-table” “complications” “cholesterol”  
“obesity” “hypertension” “life-expectancy” “antihyperglycemic” “cardiovascular  
disease” “coronary heart disease” “risk”**





	No. of studies	Pooled estimate RR mortality (95% CI)
<b>All studies</b>	88	3.82 (3.41–4.29)
<b>Studies commenced before 1970</b>	10	5.80 (4.20–8.01)
<b>Studies commenced between 1971–1980</b>	12	5.06 (3.44–7.45)
<b>Studies commenced between 1981–1990</b>	50	3.59 (3.15–4.09)
<b>Studies commenced after 1990</b>	16	3.11 (2.47–3.91)
<b>Studies with patients age at diagnosis before 18 y</b>	41	4.93 (4.13–5.88)
<b>Studies with patients age at diagnosis after 18 y</b>	8	2.41 (1.75–3.32)
<b>Male</b>	44	3.25 (2.82–3.73)
<b>Female</b>	44	4.54 (3.79–5.45)
<b>United Kingdom studies</b>	28	3.78 (3.13–4.57)
<b>European studies</b>	66	3.56 (3.16–4.00)
<b>Non-European studies</b>	22	4.63 (3.28–6.55)



		MEN																													
		Non-smoker						Smoker																							
Systolic Blood Pressure	Age	HBA1c (6%)		HBA1c (8%)		HBA1c (10%)		HBA1c (6%)		HBA1c (8%)		HBA1c (10%)																			
		180	75	8.0	7.6	7.2	6.8	6.7	7.2	6.9	6.5	6.2	6.0	6.5	6.2	5.8	5.6	5.4	6.7	6.4	6.0	5.7	5.4	6.1	5.6	5.3	5.0	4.8	5.5	5.0	4.7
160	75	8.6	8.3	8.0	7.6	7.3	8.0	7.7	7.3	6.9	6.7	7.3	6.8	6.5	6.3	6.1	7.3	6.9	6.5	6.3	6.1	6.8	6.2	6.0	5.7	5.4	6.0	5.7	5.4	5.1	4.8
140	75	9.1	8.8	8.4	8.1	7.8	8.7	8.2	7.8	7.6	7.4	8.0	7.5	7.2	6.9	6.6	7.8	7.4	7.0	6.9	6.5	7.3	6.8	6.5	6.2	6.0	6.7	6.3	6.0	5.7	5.4
120	75	9.6	9.2	9.0	8.7	8.4	9.1	8.7	8.5	8.1	7.9	8.4	8.1	7.8	7.5	7.1	8.2	7.8	7.5	7.3	7.1	7.7	7.4	7.0	6.8	6.4	7.1	6.8	6.5	6.2	5.9
180	65	13.0	12.7	12.2	11.7	11.2	12.3	11.7	11.4	10.7	10.3	11.2	10.8	10.1	9.6	9.5	11.4	10.9	10.4	10.0	9.5	10.5	10.1	9.7	9.1	8.8	9.7	9.1	8.6	8.2	8.0
160	65	13.8	13.4	13.1	12.6	11.9	13.3	12.6	12.2	11.7	11.2	12.2	11.6	11.1	10.7	10.4	12.1	11.7	11.2	10.7	10.3	11.3	10.8	10.3	9.9	9.5	10.4	10.1	9.5	9.0	8.7
140	65	14.5	14.0	13.7	13.1	12.9	14.0	13.3	12.8	12.5	12.0	13.0	12.4	11.8	11.6	11.1	12.6	12.2	11.7	11.4	10.9	11.9	11.6	11.1	10.8	10.5	11.2	10.6	10.2	9.9	9.4
120	65	14.9	14.6	14.1	13.8	13.4	14.4	14.0	13.5	13.2	12.7	13.6	13.1	12.8	12.3	11.9	13.1	12.8	12.5	12.1	11.7	12.7	12.1	11.7	11.3	10.9	11.8	11.4	10.8	10.5	10.1
180	55	19.3	18.7	18.5	17.9	17.4	18.4	17.8	17.4	16.8	16.5	17.4	16.9	16.1	15.8	15.3	17.6	16.7	16.4	15.8	15.2	16.5	15.9	15.4	14.8	14.3	15.6	14.7	14.2	13.7	13.2
160	55	20.3	19.8	19.2	18.7	18.4	19.4	18.9	18.3	17.8	17.3	18.4	17.8	17.2	16.8	16.3	18.2	17.7	17.3	16.6	16.3	17.4	17.0	16.2	15.8	15.1	16.5	15.6	15.3	14.6	14.2
140	55	20.8	20.4	19.9	19.5	19.0	20.2	19.7	19.1	18.6	18.4	19.1	18.9	18.3	17.6	17.1	18.8	18.4	18.0	17.4	17.0	18.1	17.6	17.2	16.6	16.1	17.3	16.5	16.0	15.6	15.1
120	55	21.1	20.8	20.4	20.2	19.6	20.6	20.1	19.9	19.3	18.9	19.9	19.6	19.0	18.4	18.0	19.2	18.9	18.4	18.1	17.6	18.8	18.2	17.7	17.2	16.8	18.0	17.3	16.7	16.4	15.8

		WOMEN																													
		HBA1c (6%)				HBA1c (8%)				HBA1c (10%)				HBA1c (6%)				HBA1c (8%)				HBA1c (10%)									
180	75	10.1	9.7	9.3	9.0	8.8	9.2	8.9	8.5	8.2	7.9	8.3	7.9	7.7	7.4	7.1	8.7	8.4	8.0	7.7	7.4	8.0	7.6	7.2	6.9	6.7	7.1	6.8	6.4	6.1	5.9
160	75	10.8	10.5	10.1	9.8	9.6	10.1	9.7	9.4	9.1	8.8	9.2	8.8	8.4	8.2	7.9	9.4	9.1	8.8	8.4	8.2	8.7	8.4	8.0	7.7	7.4	8.0	7.5	7.2	7.0	6.7
140	75	11.4	11.0	10.8	10.4	10.3	10.7	10.3	10.0	9.9	9.4	10.0	9.6	9.4	8.9	8.6	10.3	9.9	9.3	9.0	8.8	9.2	9.0	8.8	8.4	8.1	8.7	8.2	7.8	7.7	7.4
120	75	11.7	11.5	11.3	11.0	10.8	11.4	11.1	10.6	10.4	10.1	10.7	10.2	10.1	9.6	9.4	10.3	10.0	9.7	9.5	9.2	9.8	9.4	9.3	8.9	8.6	9.2	8.9	8.6	8.2	8.0
180	65	14.9	14.5	14.2	13.8	13.5	14.2	13.7	13.3	12.8	12.6	13.1	12.6	12.3	11.8	11.6	13.3	12.8	12.5	12.1	11.7	12.5	12.0	11.7	11.1	10.9	11.6	11.1	10.6	10.1	9.8
160	65	15.5	15.3	14.9	14.6	14.3	14.9	14.5	14.2	13.9	13.3	14.1	13.6	13.3	12.9	12.7	13.9	13.5	13.1	12.8	12.6	13.3	13.0	12.5	12.0	11.8	12.5	11.9	11.5	11.1	10.7
140	65	16.0	15.8	15.4	15.3	15.0	15.6	15.2	15.0	14.6	14.2	14.9	14.5	14.3	13.8	13.4	14.3	14.2	13.7	13.4	13.1	13.9	13.6	13.0	12.9	12.5	13.3	12.6	12.3	11.9	11.7
120	65	16.5	16.2	16.1	15.8	15.4	15.9	15.7	15.5	15.2	15.0	15.5	15.1	14.7	14.5	14.2	14.8	14.4	14.1	14.0	13.7	14.3	14.0	13.7	13.4	13.2	13.8	13.4	13.0	12.6	12.3
180	55	20.2	20.0	19.4	19.1	18.9	19.5	19.2	18.8	18.4	18.1	18.7	18.3	17.6	17.3	16.9	18.5	18.0	17.6	17.5	17.0	17.7	17.5	16.9	16.6	16.2	16.9	16.2	15.9	15.4	15.0
160	55	21.0	20.7	20.5	20.2	19.8	20.3	20.0	19.6	19.6	18.9	19.5	19.0	18.7	18.3	17.9	18.9	18.6	18.5	18.1	17.7	18.5	18.1	17.8	17.4	17.0	17.7	17.2	16.8	16.4	16.0
140	55	21.3	21.1	20.8	20.5	20.3	21.0	20.7	20.3	20.0	19.8	20.3	19.9	19.6	19.2	18.8	19.4	19.2	18.9	18.6	18.4	18.9	18.7	18.4	17.9	17.8	18.4	17.9	17.7	17.2	16.7
120	55	21.8	21.3	21.1	21.0	20.8	21.3	21.0	20.7	20.4	20.1	20.8	20.5	20.2	19.9	19.5	19.8	19.5	19.2	19.1	18.8	19.4	19.1	18.7	18.4	18.3	18.8	18.5	18.2	17.9	17.5

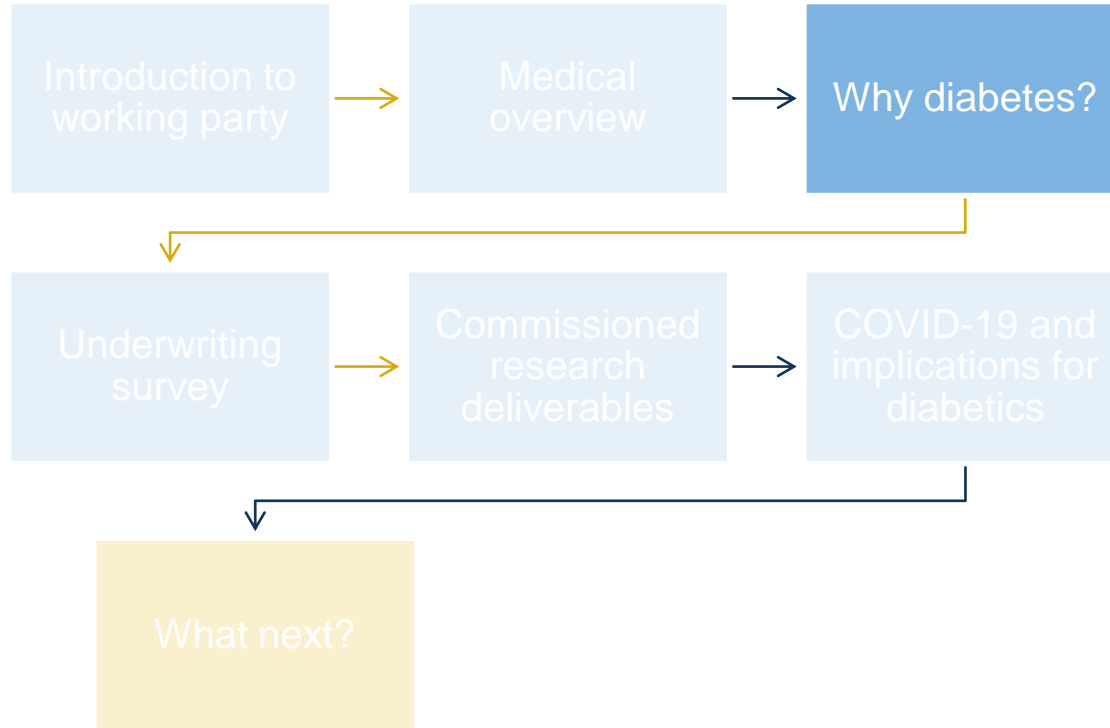


**Instructions on how to use the Tables:**  
 1) Identify the table relating to the person's age, smoking history, and HBA1c level.  
 2) Within the table choose the cell nearest to the person's total:HDL ratio and systolic blood pressure.

- ### Key risks factors
- Hypertension
  - Poor glycaemic control
  - Smoker
  - Older age
  - Male
  - Raised cholesterol



# Agenda



# Why diabetes?

## Size



- WHO, Global Report on Diabetes, 2016, adult population:
  - **Globally estimated 422 million living with diabetes in 2014 (vs 108 million 1980)**
  - **Global prevalence (age standardised) of diabetes has doubled since 1980 (4.7% to 8.5%)**
- Public Health England, Diabetes Prevalence Model, 2016 (diagnosed and undiagnosed):
  - **UK estimated 3.8 million people** ages 16 and over in England have diabetes (8.6% of population)
  - **By 2035, diabetes prevalence is expected to increase to 4.9 million or 9.7%**

## Societal Issues



- **Widen insurance** coverage for those with diabetes
- **Collaborate** with **diabetic organisations**
- **Contribute** to UK Government debate e.g. green paper on “**Prevention is Better than Cure**” (2018)

## Modifiable risk

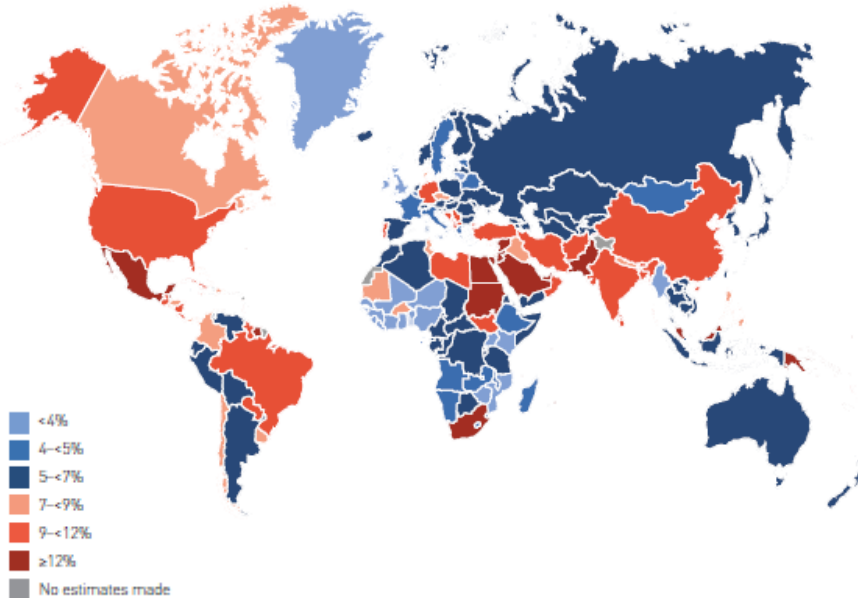


- Type 1 diabetes can be managed by **regular monitoring of insulin and glucose levels** combined with a **healthy lifestyle**
- Type 2 can be effectively managed by **reducing overweight** and **adopting a healthy lifestyle** (diet and physical activity), combined with **medication when required**
- **Rapid advances in technology over time can be used to improve risk**



# Global prevalence

Estimated age-adjusted comparative prevalence of diabetes in adults (20–79 years) in 2019



Source: IDF DIABETES ATLAS, Ninth edition 2019

- MENA<sup>1</sup> has highest age adjusted diabetes prevalence ages 20-79 of 13.9%, followed by NAC<sup>2</sup> 13.0% followed close by WP<sup>3</sup> 12.8% and SEA<sup>4</sup> 12.6%
- Prevalence of diabetes in higher and High Income Countries (World bank income classification)
- Woman have slightly lower prevalence compared to men (9.0% vs 9.6%)
- Prevalence increases by age
- 1 in 2 people are undiagnosed globally (type 2)
- 10% of global health expenditure is spent on diabetes



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# Global – diabetes report 2010 to 2045

## Number of adults (20–79 years) with diabetes worldwide

### North America & Caribbean



- 1 in 6 adults in this Region is at risk of type 2 diabetes
- 43% of global diabetes-related health expenditure occurs in this Region

### South & Central America



- 2 in 5 people with diabetes were undiagnosed
- Only 9% of global diabetes-related health expenditure for diabetes is spent in this Region

### Africa



- 3 in 5 people with diabetes are undiagnosed
- 3 in 4 deaths due to diabetes were in people under the age of 60

### Middle East & North Africa



- 1 in 8 people have diabetes
- 1 in 2 deaths due to diabetes were in people under the age of 60

### South-East Asia



- 1 in 5 adults with diabetes lives in this Region
- 1 in 4 live births are affected by hyperglycaemia in pregnancy

### Western Pacific



- 1 in 3 adults with diabetes lives in this Region
- 1 in 3 deaths due to diabetes occur in this Region

## WORLD



### Europe



- 1 in 6 live births are affected by hyperglycaemia in pregnancy
- The Region has the highest number of children and adolescents (0–19 years) with type 1 diabetes – 297,000 in total

Source: IDF DIABETES ATLAS, Ninth edition 2019, <https://www.diabetesatlas.org/data/en/world/>



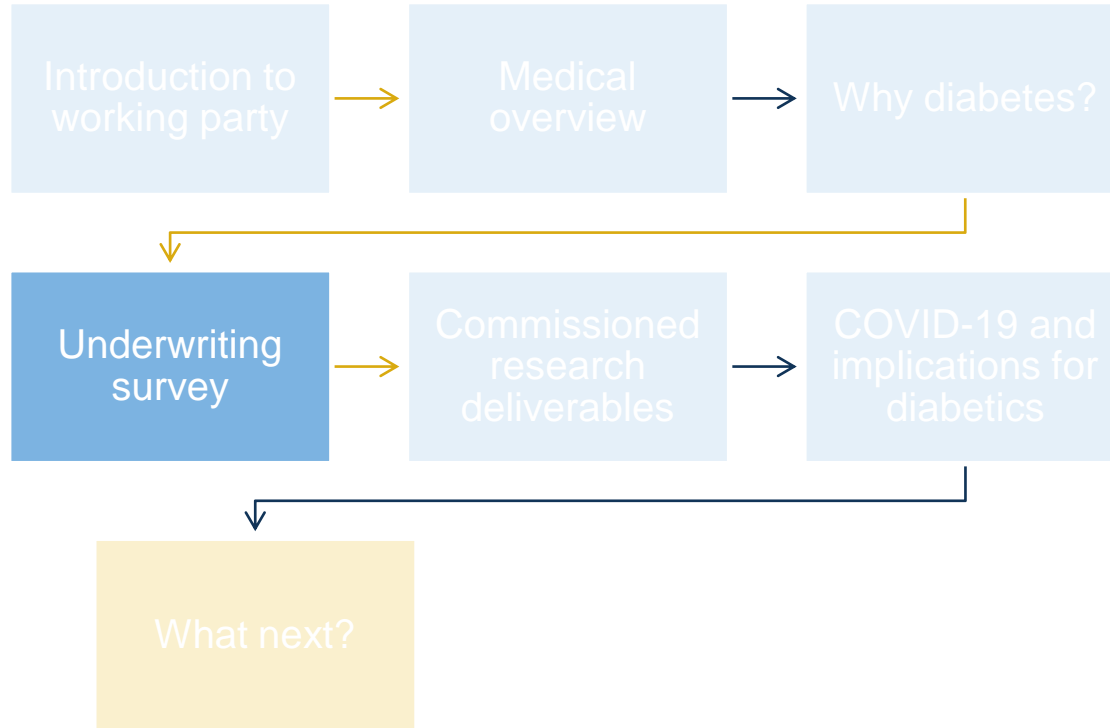
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# Key messages

Can the insurance industry act to encourage a change in behaviour of our customers to prevent/postpone early diabetes related deaths and later in life chronic conditions



# Agenda





# How do we underwrite diabetics today?

## Guidelines



- **Internal** and/or **reinsurers** manuals
- **Type 1** and **type 2**
- **Impaired glucose tolerance and pre-diabetes**
- **Product**

## Range of measures used in initial underwriting



- **HbA1c**
- **BMI**
- **Cholesterol**
- **Blood pressure** - diastolic/systolic
- **Smoking**
- **Duration since diagnosed**
- **Complications of diabetes developed**



# Underwriting survey and link to research

## Size of survey

- **20 different insurers / reinsurers** responded

## Key observations



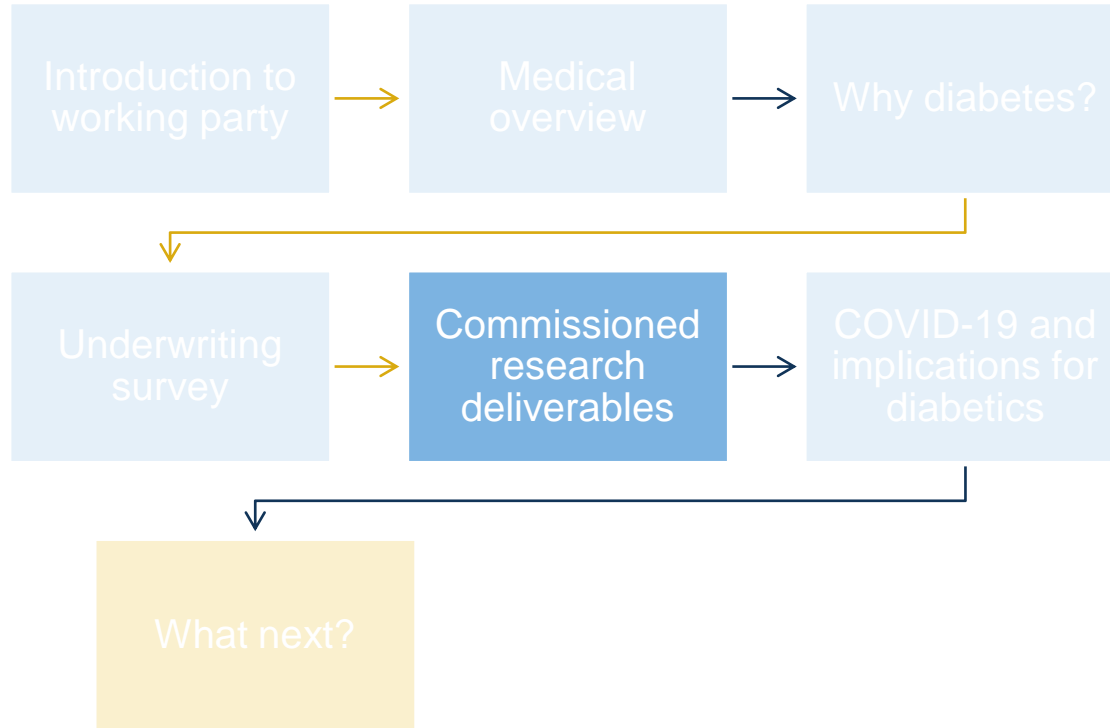
- **Pre-diabetes**
  - Only a minority ask about pre-diabetes so this is potentially an area where research could add greater insight
- **Only 30% follow reinsurers manual 100%**
- **Gender doesn't appear to impact diabetes underwriting decision** (only 15% consider gender)
- **Only 10% of respondents use physical data points**
- **Survey highlights better access to HbA1c data may be useful in providing a more accurate assessment**
- **Medical evidence**
- **Products offered (1 is very unlikely and 5 very likely)**
  - Life average between 4-5
  - **All other benefits including critical illness, disability (lump sum or regular payment) average just above 1**

## Link to research

- **Pre-diabetes is a key part of the research** and is important for **prevention**
- **HbA1c is a key relative risk factor included in our research** along with interaction with other factors
- **Research in incidence and cause of disability** will enable a **better understanding** of nature of the disability



# Agenda



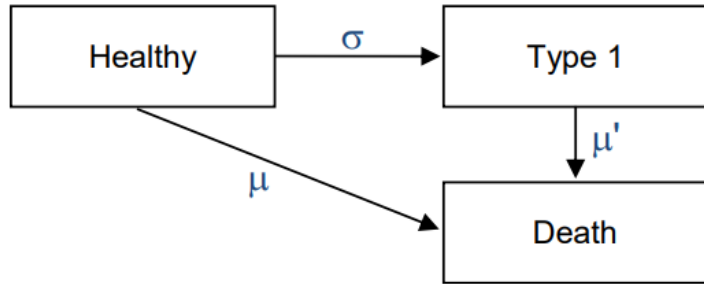
# Deliverables of commissioned research

Relative risk factors	<ul style="list-style-type: none"><li>• <b>Understanding of the underlying drivers</b></li><li>• <b>Risk factors</b></li></ul>
Interaction between the risk factors	<ul style="list-style-type: none"><li>• <b>Understanding the interactions</b> between the risk factors and confounding effects</li><li>• <b>How any of the known variables that drive risk interact</b> in terms of their individual and cumulative impact</li></ul>
Mortality and morbidity base levels	<ul style="list-style-type: none"><li>• <b>Healthy lives</b> (excluding Type 1, Type 2 and lives that would be rated in an insurance context)</li><li>• <b>Lives at risk of diabetes</b> (Pre-diabetes 2)</li><li>• <b>Diabetic (Type 1 and Type 2)</b></li><li>• <b>Diabetic Type 2 recoveries</b></li></ul>
Cause of death or cause of disability	<ul style="list-style-type: none"><li>• Split of mortality rate by <b>cause of death</b></li><li>• Investigate <b>chronic conditions</b> present prior to death</li></ul>
Trend in diabetes over time cause of disability	<ul style="list-style-type: none"><li>• <b>Examine trends</b> in experience over the past 10 years using publicly available data</li><li>• Future projections of trends is not in scope</li></ul>



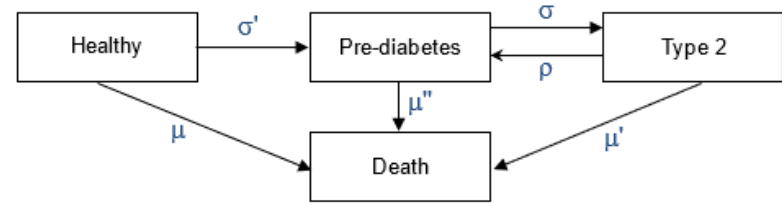
# Mortality and morbidity base level transitions

- Transitions for Type 1 diabetes



- Mortality ( $\mu$  and  $\mu'$ ) and incidence ( $\sigma$ )

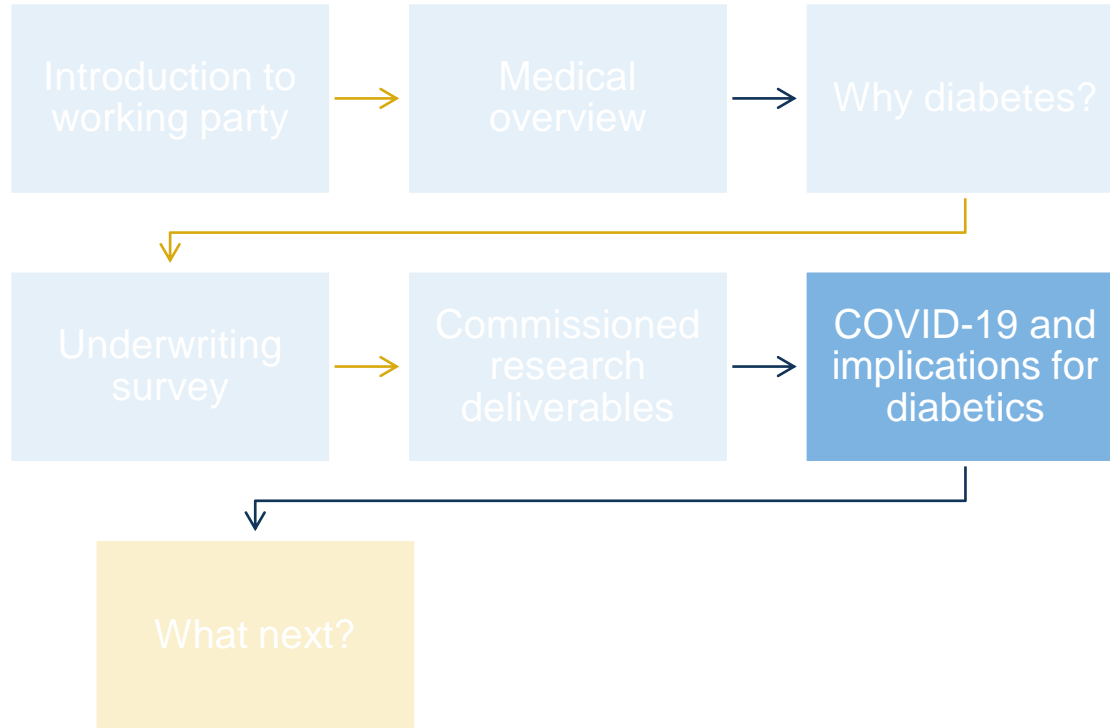
- Transitions for Type 2 diabetes

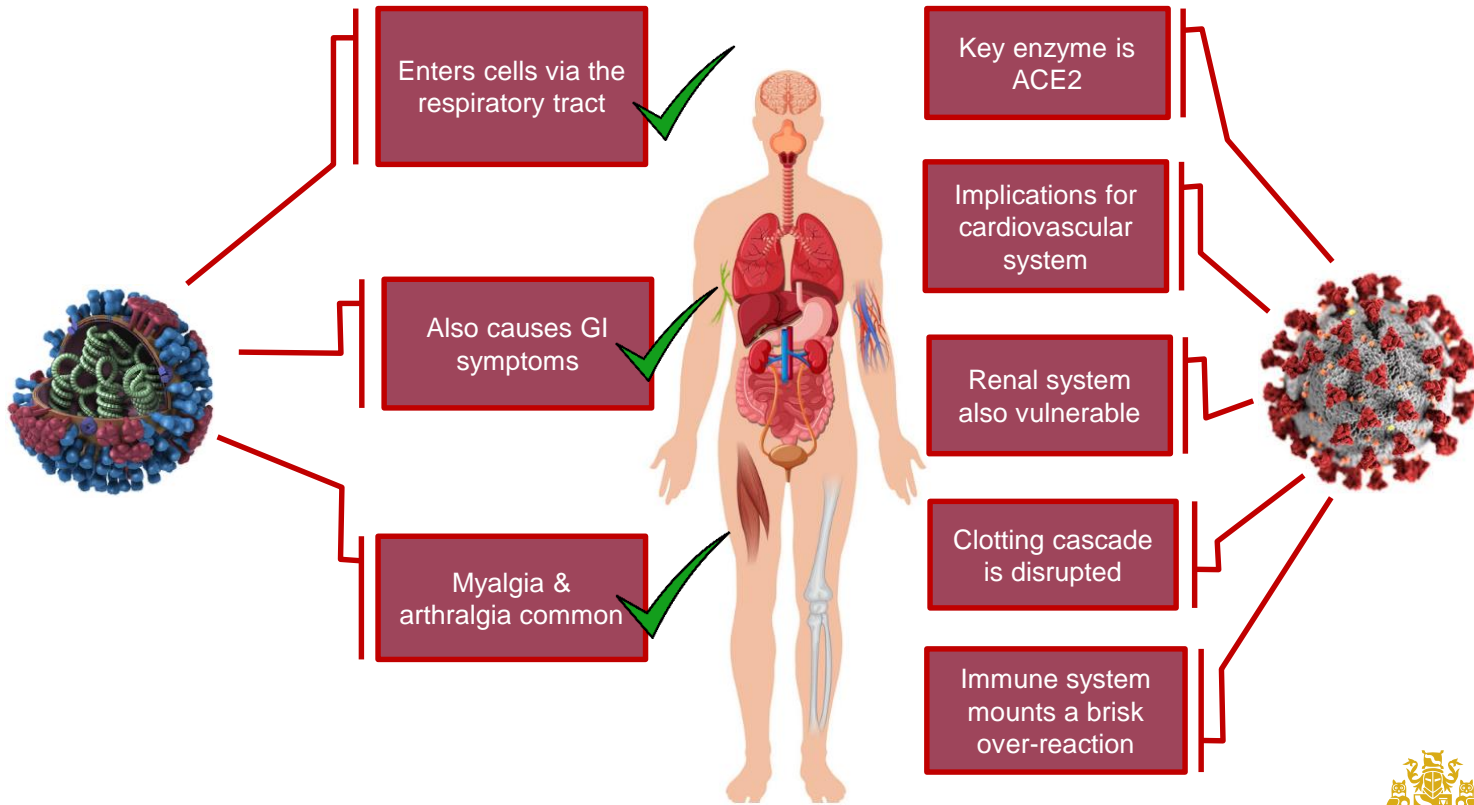


- Mortality ( $\mu$ ,  $\mu'$ ,  $\mu''$ ), incidence ( $\sigma$  and  $\sigma'$ ) and recovery ( $\rho$ ) back to pre-diabetic

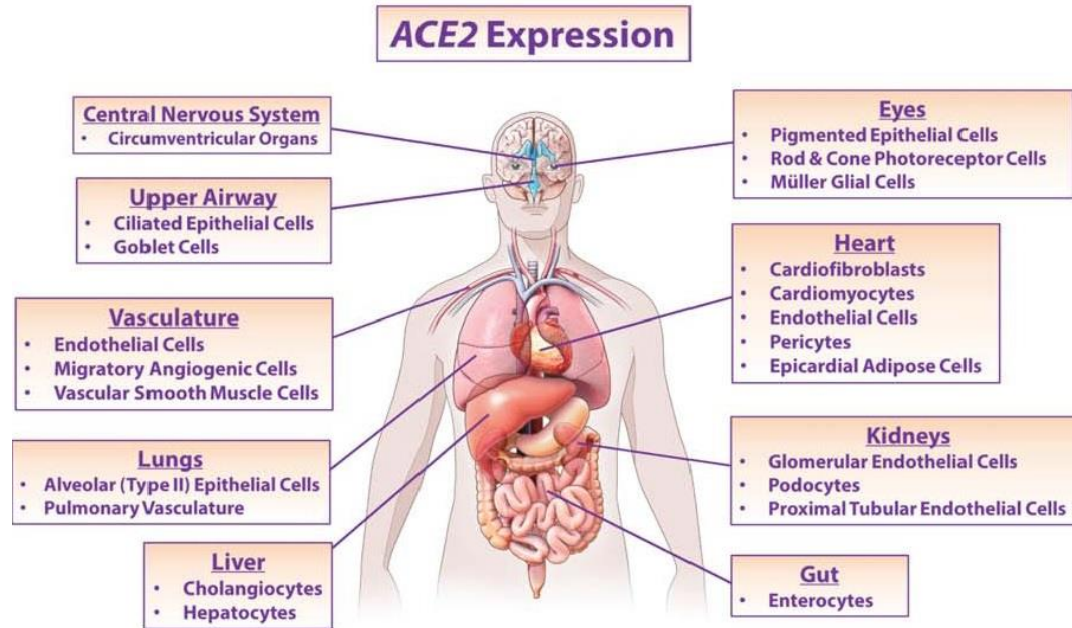


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Since ACE2 is expressed and plays important roles in a variety of organs and tissues (lungs, cardiovascular system, gut, kidneys, central nervous system, and adipose tissue), it provides the critical link between infection by SARS-CoV-2, immunity, inflammation and cardiovascular disease





**In general, people with diabetes are at higher risk to develop complications when they are infected with a virus**

**Type 2 diabetes is associated with a low-grade chronic inflammation**

**In 2006, it was reported that ambient hyperglycemia was an independent predictor for mortality and morbidity in severe acute respiratory syndrome (SARS) patients**

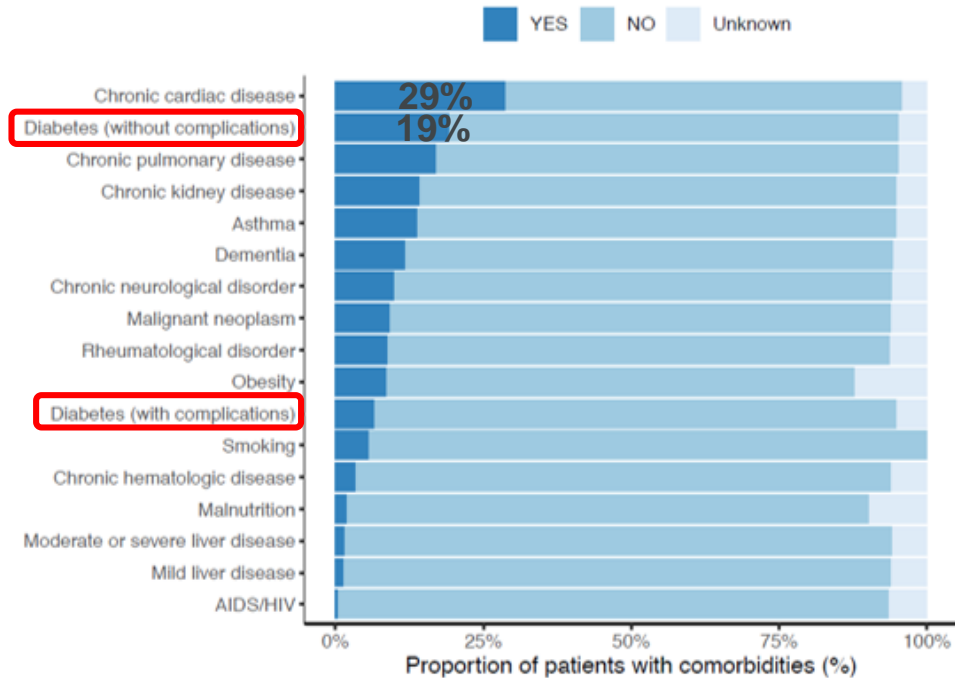
**Diabetes as a distinctive comorbidity is associated with more severe disease, acute respiratory distress syndrome and increased mortality**

**Chronic inflammation, increased coagulation activity, immune response impairment, and potential direct pancreatic damage by SARS-CoV-2 might be among the underlying mechanisms of the association between diabetes and COVID-19**



# Features of 16,749 hospitalised UK patients with COVID-19 using the ISARIC WHO Clinical Characterisation Protocol

Comorbidity (% patients, n = 11412)



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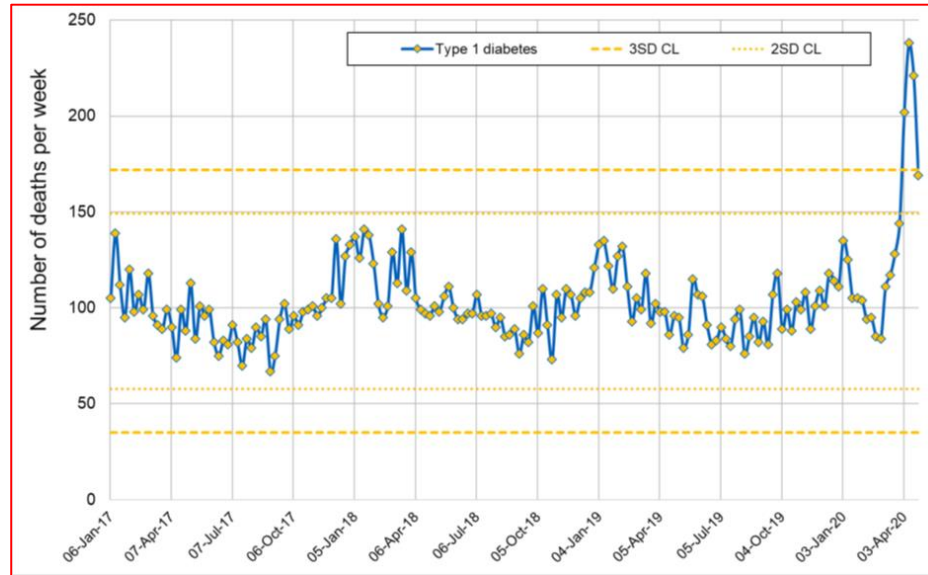
# OpenSAFELY: factors associated with COVID-19-related hospital death in the linked electronic health records of 17 million adult NHS patients.

## Hazard Ratios (HRs) and 95% confidence intervals (CI) for in-hospital COVID-19 death

Diabetes (vs none)	Death HR (95% CI)	
	Age-sex adjusted	Fully adjusted
Controlled (HbA1c<58 mmol/mol)	2.02 (1.89-2.16)	1.50 (1.40-1.60)
Uncontrolled (HbA1c>=58 mmol/mol)	3.61 (3.34-3.90)	2.36 (2.18-2.56)
No recent HbA1c measure	2.35 (2.04-2.70)	1.87 (1.63-2.16)



# Type 1 and Type 2 diabetes and COVID-19 related mortality in England: a cohort study in people with diabetes

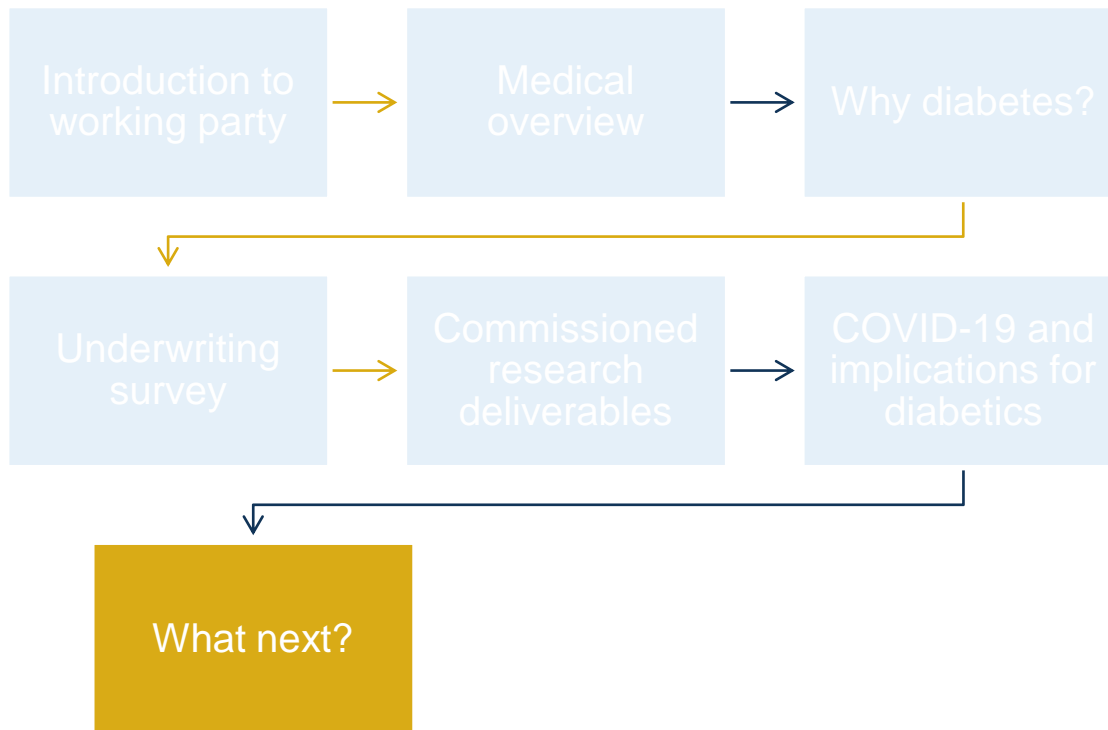


## Weekly number of deaths in people with Type 1 diabetes in England January 2017-April 2020

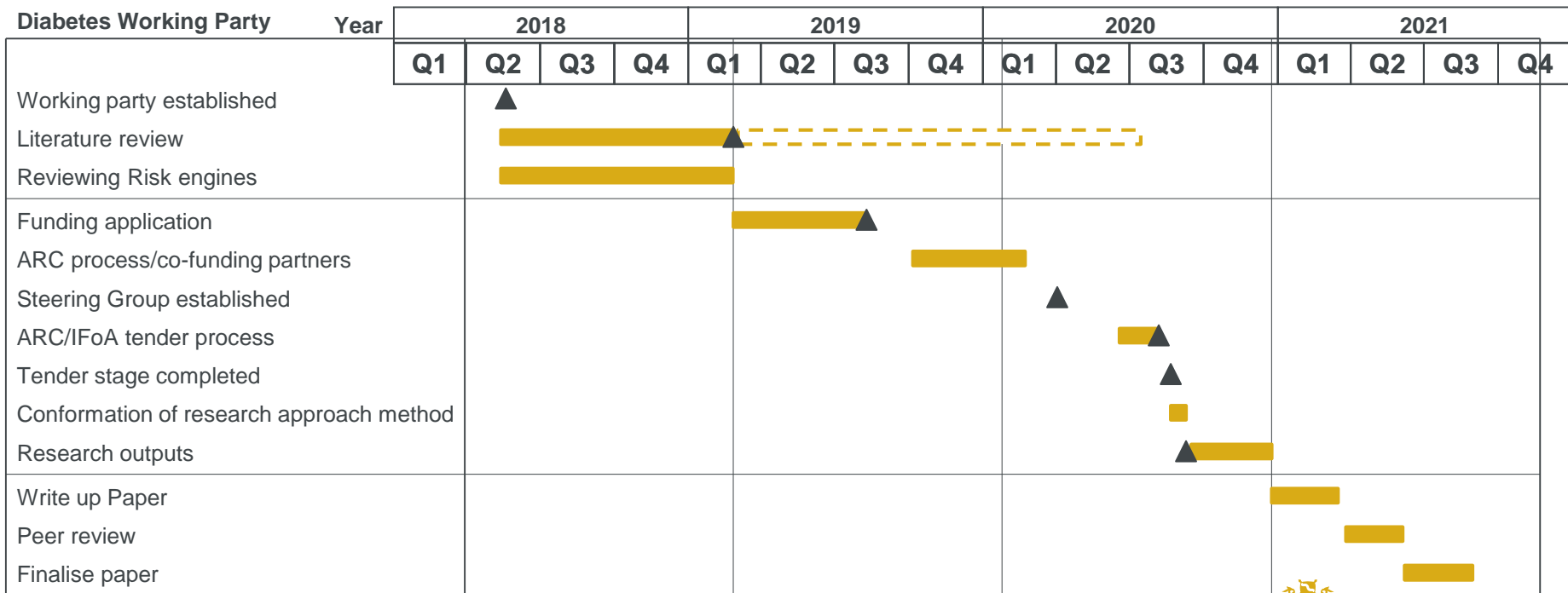


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# Where we are?





- Published data does not reflect current experience
- Dietary & other lifestyle changes
- Newer, more effective pharmaceutical management
- *“One of the major factors for mortality is therapeutic inertia”* -Prof Khunti
- *“We put the low carbohydrate diet on trial to prove there is no evidence that the diet is dangerous. In the end we won and set a legal precedent.”* – Prof Noakes





**Questions**



**Comments**

Expressions of individual views by members of the Institute and Faculty of Actuaries and its staff are encouraged.

The views expressed in this presentation are those of the presenter.

