



Addressing Cardiometabolic Risk in Children and Adolescents: CHALLENGES AND SOLUTIONS

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Type 2 Diabetes in Children and Adolescents: Screening, Diagnosis, and Management

Jay H. Shubrook DO FACOFP, FAAFP
Professor, Primary Care Department
Primary Care Diabetologist
Touro University California
jshubroo@touro.edu



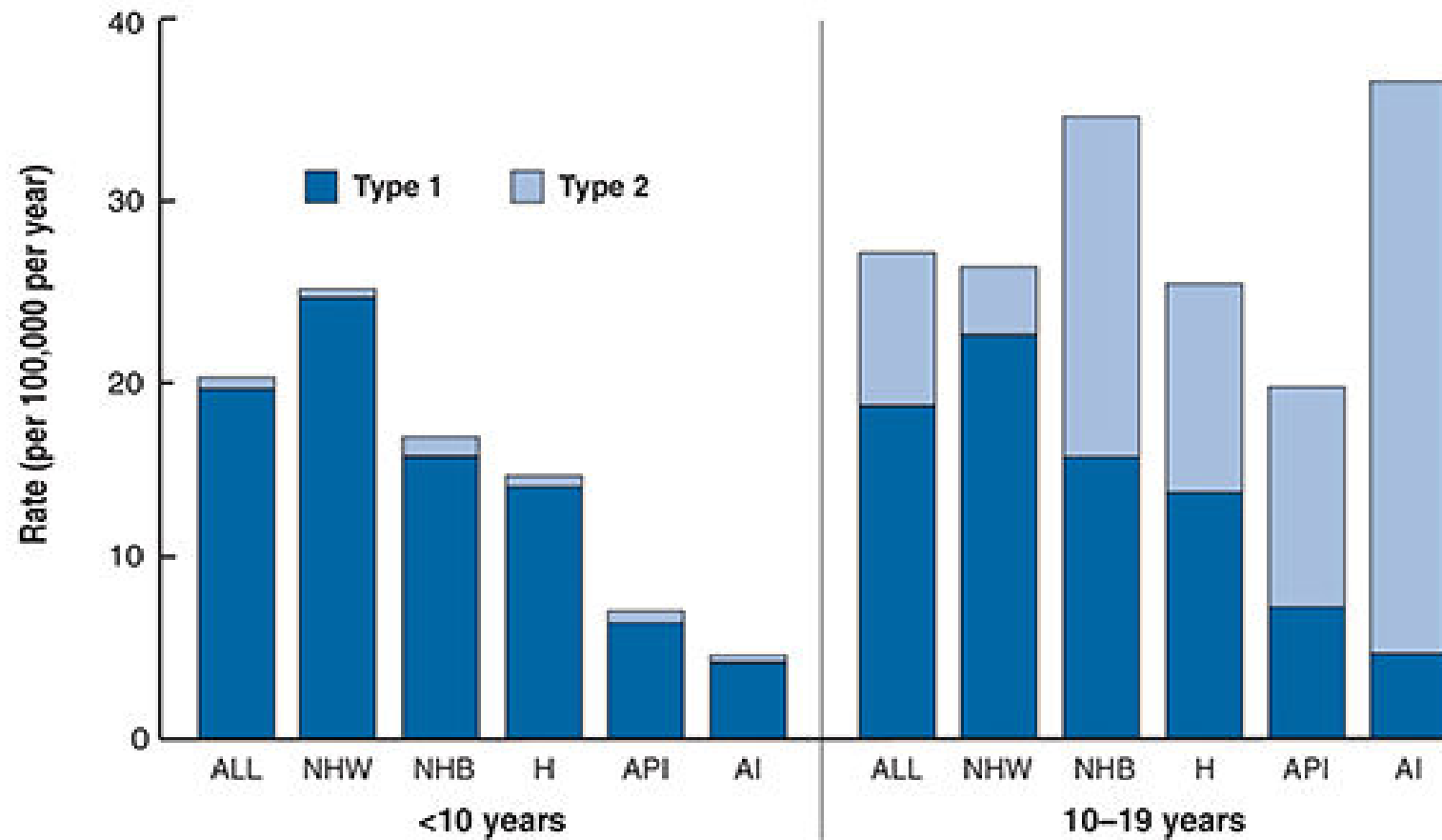
Goals

- Review the evolving epidemiology of type 2 diabetes in children and adolescents
- Review screening recommendations
- Discuss diagnostic criteria for children
- Compare and contrast treatment methods for type 2 diabetes in children and adolescents

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Rate of new cases of type 1 and type 2 diabetes among youth ages younger than 20 years, by race/ethnicity, 2002–2005



Source: SEARCH for Diabetes in Youth Study

NHW=non-Hispanic whites; NHB=non-Hispanic blacks; H=Hispanics/Latinos;

API=Asian/Pacific Islander Americans; AI=American Indians

Diabetes Care. 2016;39(9):1635-1642. doi:10.2337/dc16-1066

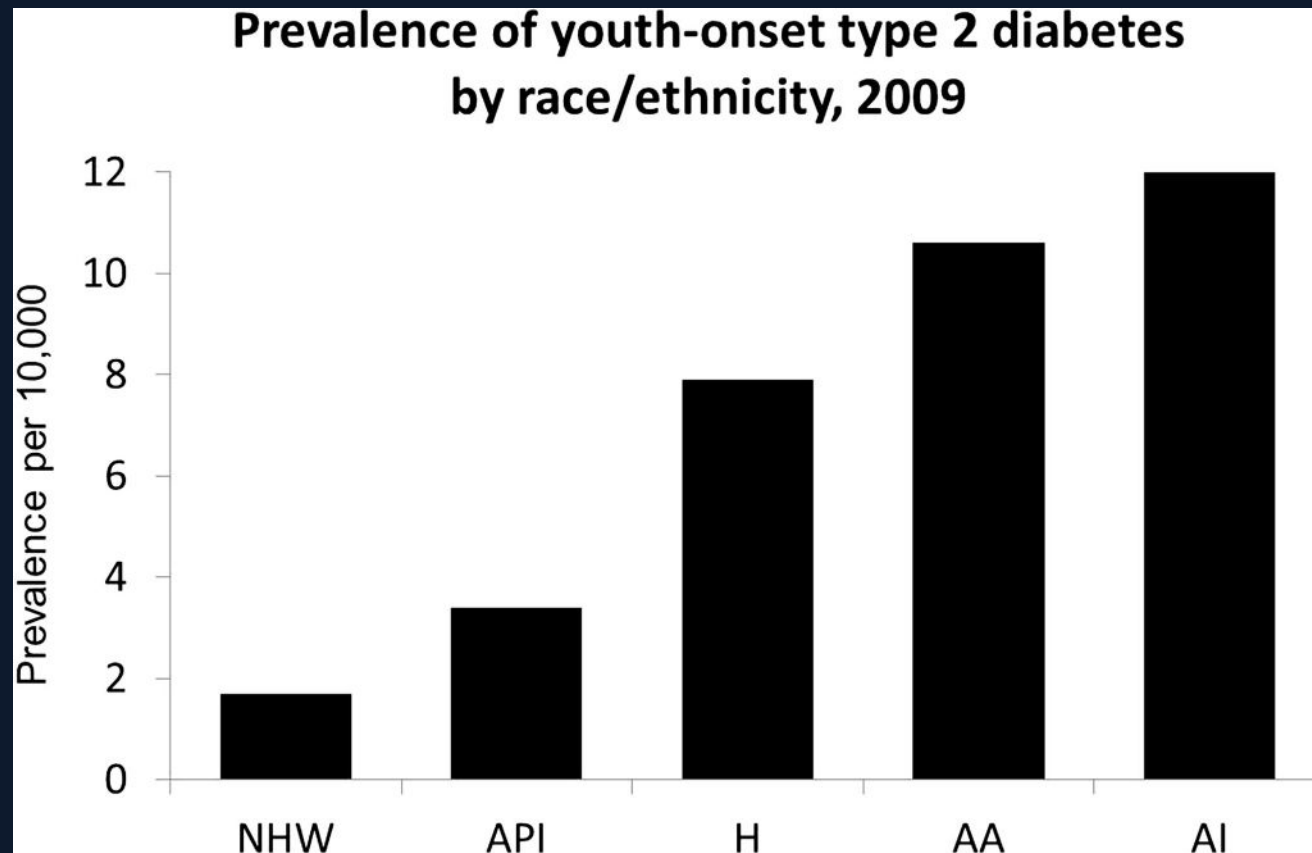


Figure Legend:

Prevalence of youth-onset type 2 diabetes by race/ethnicity. 2009 prevalence of type 2 diabetes among youth, as published by the SEARCH for Diabetes in Youth study (4). Prevalence is reported per 10,000 population at risk for type 2 diabetes (ages 10–19 years). AA, African American; AI, American Indian; API, Asian Pacific Islander; H, Hispanic; NHW, non-Hispanic white.

Type 2 Diabetes in Youth

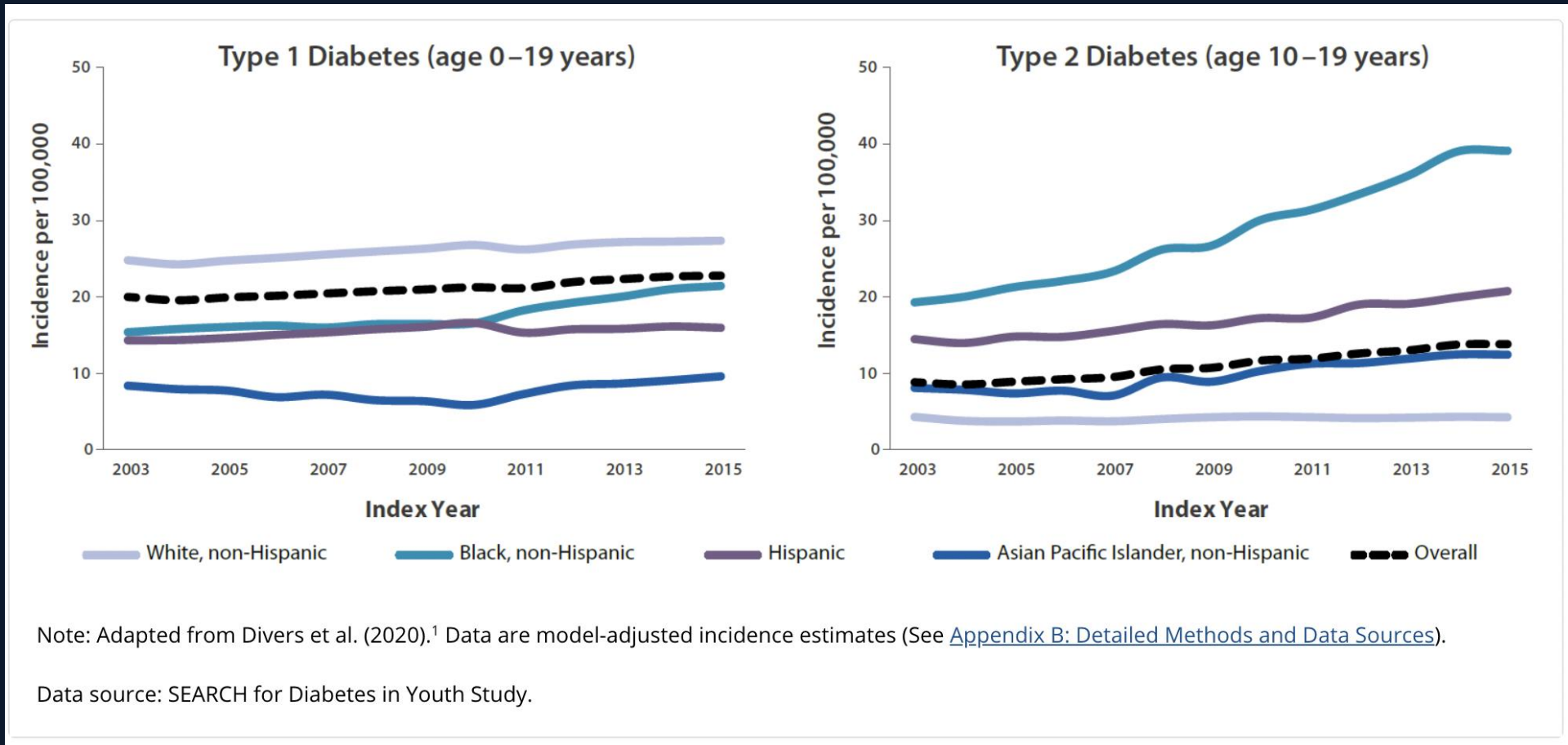
- 33% of all adolescents in US with DM have TYPE 2 (1)
 - Over-representation from ethnic and racial minorities
 - Hispanic/Latino
 - African American
 - First American
 - Filipino
- Uncommon before puberty
 - Increased 35% in US 2001-2009 (2)
 - Increased 109% 2011-2015 (3)
 - Rates much higher in females (2)
- Closely tied to Family History and Obesity

1. Alberti G, et al. IDF Workshop Type 2 Diabetes in the young. An evolving Epidemic. Diabetes Care 2004.27(7):1798-1811.

2. Diabelea D et al. Incidence of diabetes in youth in the US. JAMA 2007.297(24):2716-2724.

3. Obesity and T2DM as Documented in Private Claims Data. A FAIR Health White Paper. FAIR Health Inc. January 2017. 1-16.

Trends in Type 1 and Type 2 diabetes in youth



Risk Factors for T2DM in kids

- Excessive body weight
 - >85% of BMI for age and gender
- First American, Black, Hispanic, Pacific Islander, Asian
- FH of T2DM in first or second degree relatives
- Age 12-16 years
- Low Birth weight OR High Birth weight
- Maternal Gestational DM
- No breastfeeding
- Use of antipsychotics (increased risk x 3)

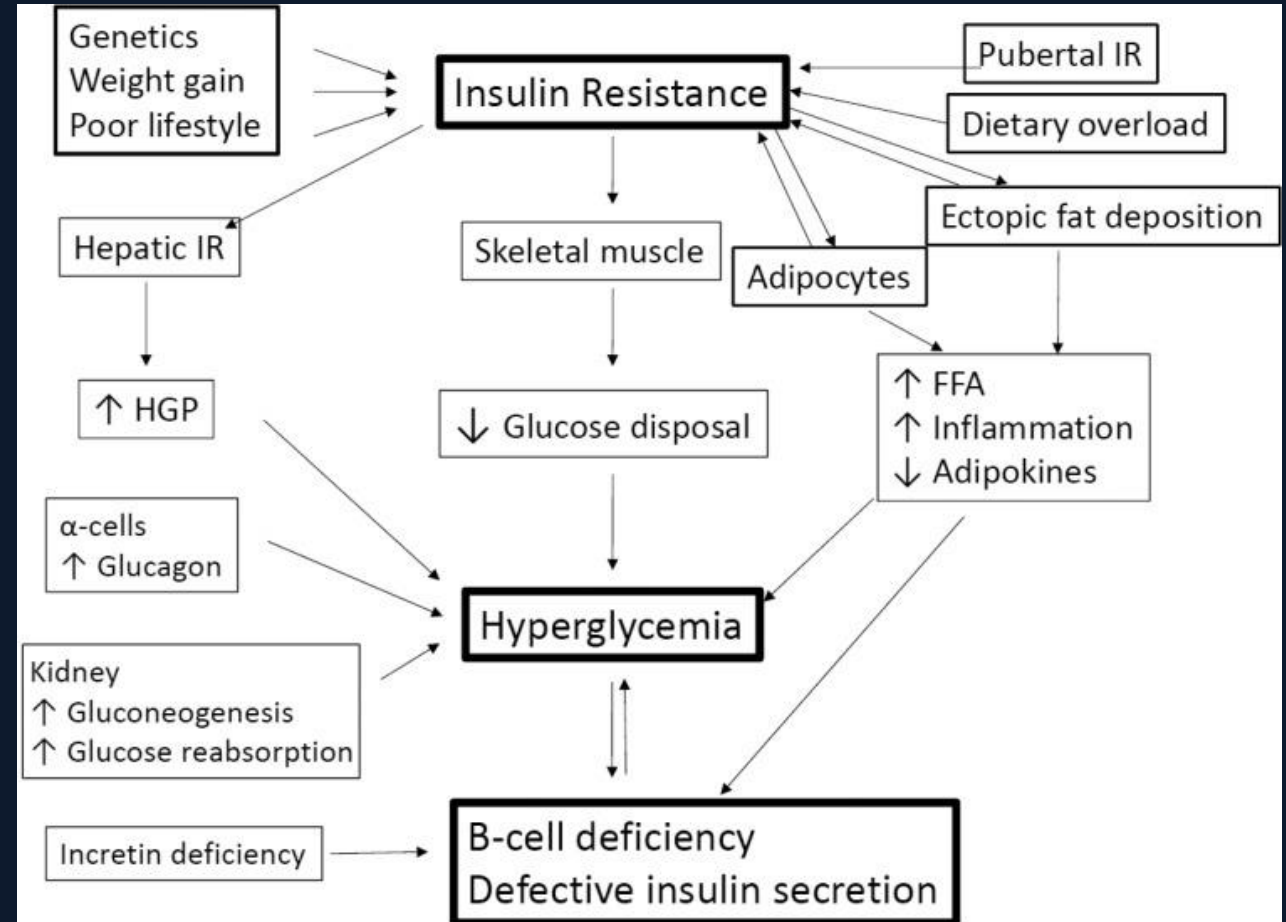
Meyer-Davis EJ et al. Diabetes Care 2008. 31(3):470-475.

Wei JN et al. Diabetes Care 2003. 26(2):343-348.

Bobo WV et al. JAMA Psychiatry 2013. 8:21.

Pathophysiology of Type 2 diabetes in children and adolescents

- Valaiyapathi B, Gower B, Ashraf AP. Pathophysiology of Type 2 Diabetes in Children and Adolescents. Curr Diabetes Rev. 2020;16(3):220-229.



Diabetes Care. 2016;39(9):1635-1642. doi:10.2337/dc16-1066

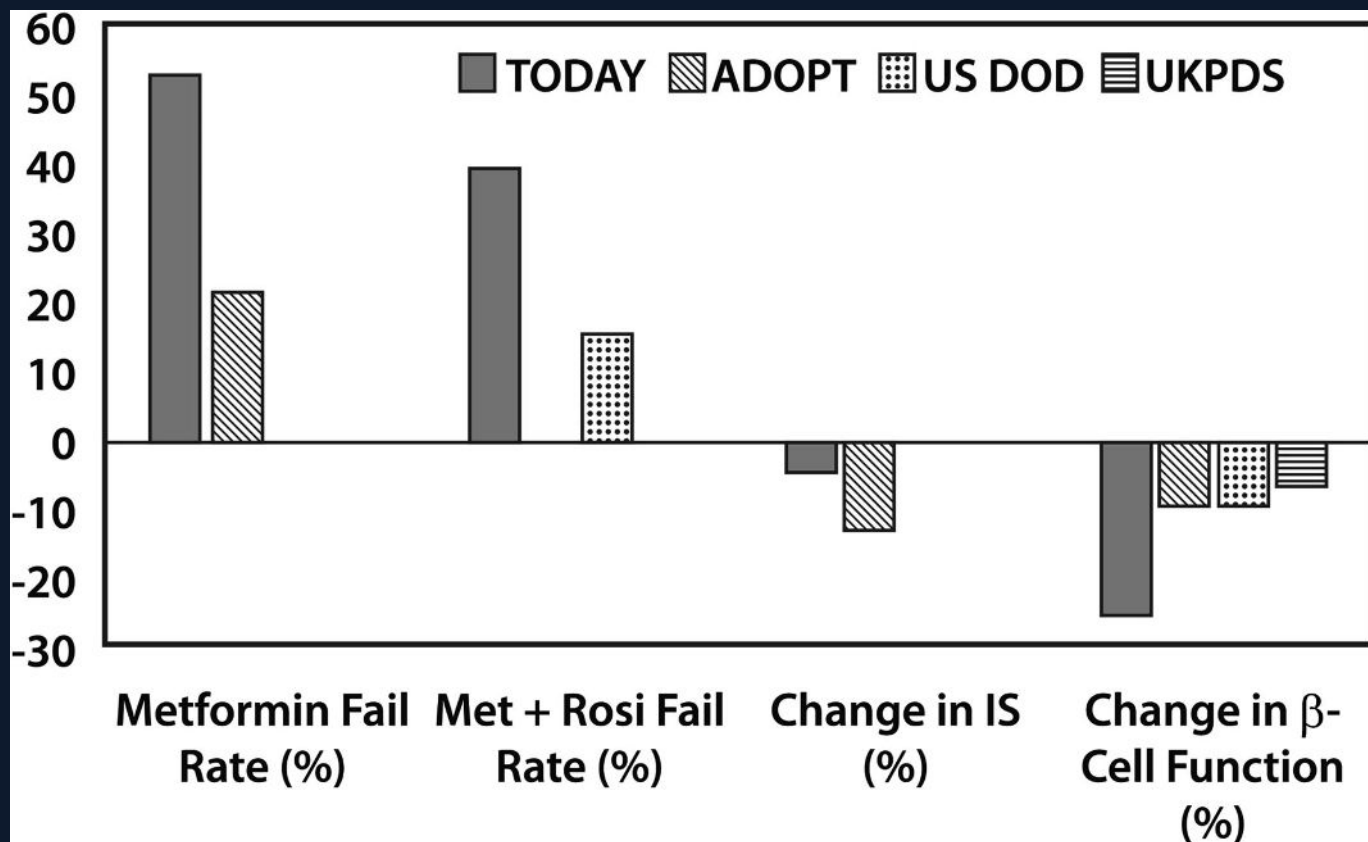


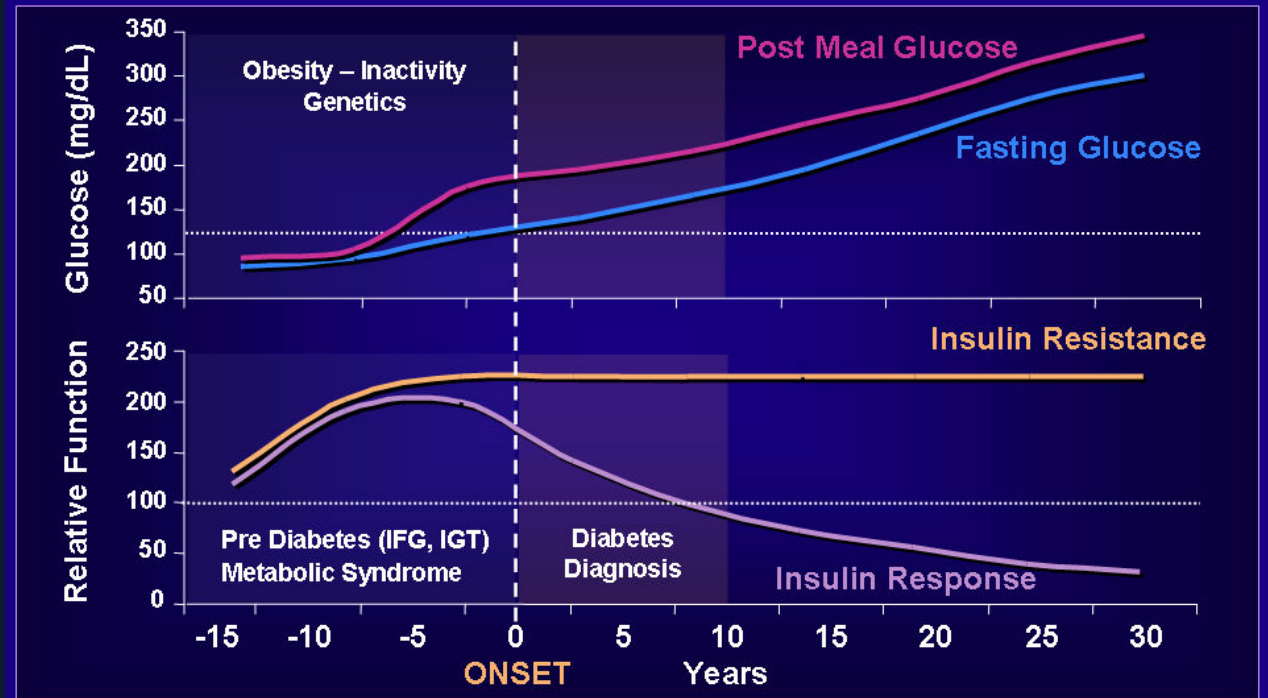
Figure Legend:

β -Cell failure rates in adults versus youth with type 2 diabetes. A comparison of medication treatment failure rates and percent change in surrogate measures of insulin sensitivity and β -cell function as reported in the TODAY study (youth) versus adult studies (A Diabetes Outcome Progression Trial [ADOPT], U.S. Department of Defense Database [US DOD], and UK Prospective Diabetes Study [UKPDS]). Note that the studies had different primary end points and therefore this is an approximate comparison, as there have been no head-to-head comparisons (11,12,14–16,67,68). Met, metformin; Rosi, rosiglitazone.

Type 2 DM Progression

- Lose 15% of beta cell function/year
- No change in insulin sensitivity-maximally resistant
 - 31% loss of insulin mediated glucose disposal
 - 78% loss of acute insulin response

Natural History of Type 2 Diabetes



Adapted from Kendall DM, Bergenstal RM © 2005 International Diabetes Center, Minneapolis, MN. All rights reserved.

Gungor N et al Progressive beta cell failure in T2DM of youth. J Pediatrics 2004.144(5):656-659.

Weyer C et al. The natural history of insulin secretory function and insulin resistance in the pathogenesis of T2DM. J Clin Invest 1999.104(6):787-794.

Goals

- Review the evolving epidemiology of type 2 diabetes in children and adolescents
- Review screening recommendations
- Discuss diagnostic criteria for children
- Compare and contrast treatment methods for type 2 diabetes in children and adolescents versus adults

There are no reliable “classic symptoms” to diagnose T2DM in youth

We must rely on evidence based national screening programs

Pre-Diabetes/Diabetes Diagnostic Criteria

<u>Normal</u>	<u>Pre-Diabetes</u>	<u>Diabetes</u>
Fasting glucose < 100 mg/dl	Impaired fasting glucose ≥ 100 - 125 mg/dl	Fasting glucose ≥ 126 mg/dl
2-h PG < 140 mg/dl	Impaired glucose tolerance 2-h PG ≥ 140 - 199 mg/dl	2-h post meal glucose ≥ 200 mg Random PG ≥ 200 + symptoms
A1C < 5.7%	5.7% to 6.4%	≥ 6.5%

Which kids should we screen for T2DM?

- Start at age 10 or onset of puberty in:
 - Any child who is overweight or obese (BMI >85%)
 - Family history in 1 or 2 degree relative
 - First American, Black, Hispanic. Asian, Pacific Islander
 - Any sign of insulin resistance:
 - Acanthosis
 - Hypertension
 - Dyslipidemia
 - PCOS
- Repeat screening every 3 years
- Fasting glucose is preferred
- Consider looking for other forms of diabetes

Case: Adolescent with dirty neck

- A 14-year-old AA female presents with concerns about a rash on her neck that will not wash away.
- Has been present for a couple years but seems to be worse.
- Child does not like it nor do parents.
- Does not seem to wash away
- Teacher said he was going to report to Children Services if nothing was done



Case: History and Physical

History

- Always obese, late menarche, bilateral knee pain
- Rash was seen by mom at event- no quick changes, nothing seems to make it better or worse
- No meds, no allergies
- FH- hypertension in both parents, DM in mom, CRF in dad
- Social- doing fair in school, some friends, lives with mom and brother, Shared custody with dad

Physical

- Obese adolescent (> 95% for gender, age and Ht)
- Truncal obesity
- Bp 148/92 (**HIGH**)

Case: labs

- A1c 9.2%. (high)
- Glucose 138 mg/dl (fasting) (high)
- AST 56 (high)
- ALT 62 (high)
- Lipid panel
 - Total chol 258 mg/dl (high)
 - HDL 30 mg/dl (low)
 - LDL 172 mg/dl
 - Trigs 380 mg/dl (high)

Where do we begin with this kid?

- Problem List
 - Insulin resistance syndrome
 - Metabolic syndrome
 - Diabetes- probably T2
 - Possible fatty liver disease
 - Dyslipidemia
 - Suspect hypertension
 - Obesity
- Where do we start?

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Management—Lifestyle Management (Type 2)

- 14.55 All youth with type 2 diabetes and their families should receive comprehensive diabetes self management education and support that is specific to youth with type 2 diabetes and is culturally appropriate. B
- 14.56 Youth with overweight/obesity and type 2 diabetes and their families should be provided with developmentally and culturally appropriate comprehensive lifestyle programs that are integrated with diabetes management to achieve 7–10% decrease in excess weight. C
- 14.57 Given the necessity of long-term weight management for children and adolescents with type 2 diabetes, lifestyle intervention should be based on a chronic care model and offered in the context of diabetes care. E

Management—Glycemic Targets (Type 2)

- 14.60 Blood glucose monitoring should be individualized, taking into consideration the pharmacologic treatment of the patient. E
- 14.61 Real-time continuous glucose monitoring or intermittently scanned continuous glucose monitoring should be offered for diabetes management in youth with type 2 diabetes on multiple daily injections or continuous subcutaneous insulin infusion who are capable of using the device safely (either by themselves or with a caregiver). The choice of device should be made based on patient circumstances, desires, and needs. E
- 14.62 Glycemic status should be assessed every 3 months. E

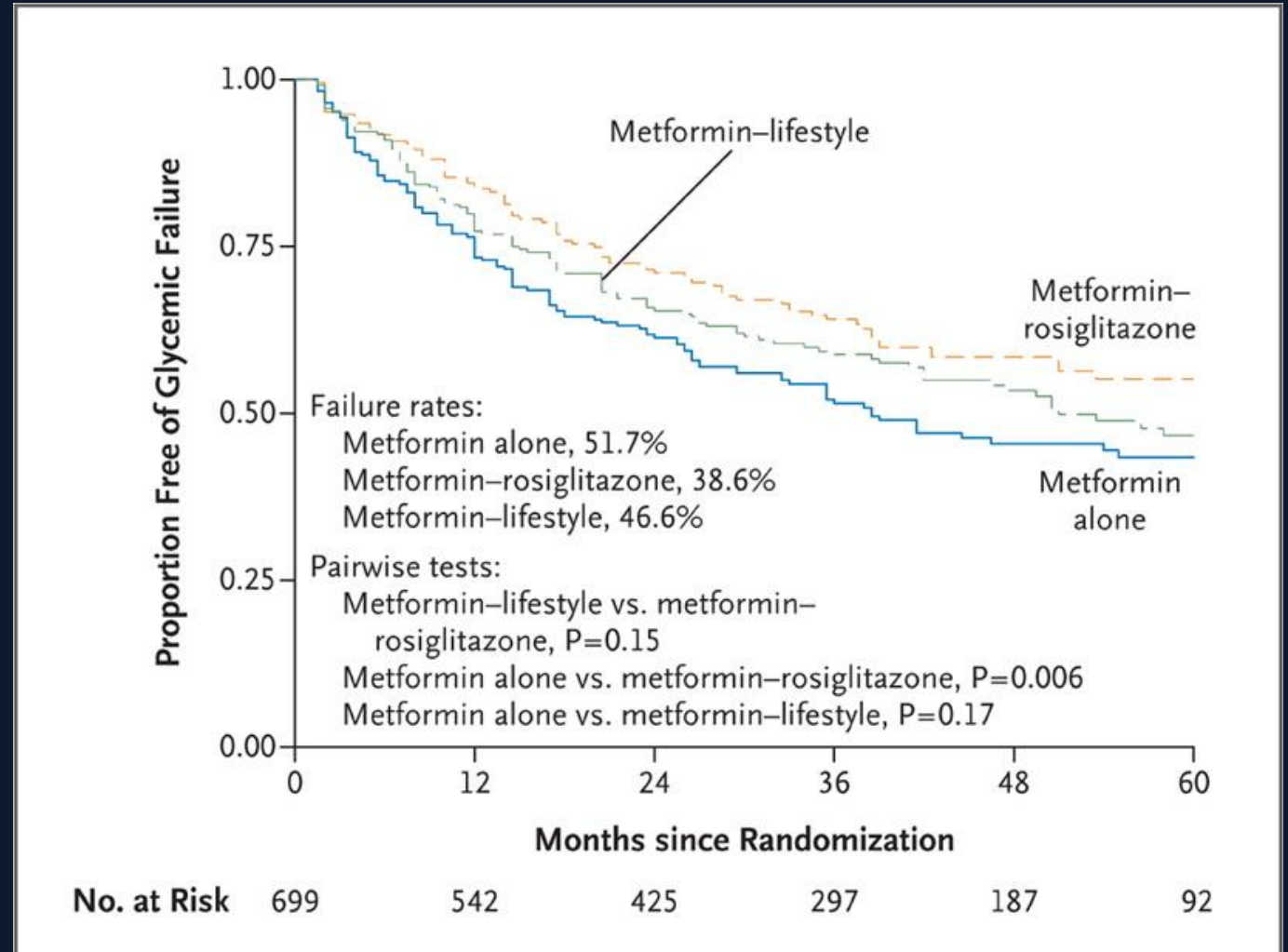
Pharmacologic Management (Type 2)

- 14.66 Initiate pharmacologic therapy, in addition to behavioral counseling for healthful nutrition and physical activity changes, at diagnosis of type 2 diabetes. A
- 14.67 In incidentally diagnosed or metabolically stable patients ($A1C < 8.5\%$ [69 mmol/mol] and asymptomatic), metformin is the initial pharmacologic treatment of choice if renal function is normal. A
- 14.68 Youth with marked hyperglycemia (blood glucose $\geq 250 \text{ mg/dL}$ [13.9 mmol/L], $A1C \geq 8.5\%$ [69 mmol/mol]) without acidosis at diagnosis who are symptomatic with polyuria, polydipsia, nocturia, and/or weight loss should be treated initially with basal insulin while metformin is initiated and titrated. B

TODAY Trial (Treatment Options for T2DM in Adolescents and Youth)

- **A Clinical Trial to Maintain Glycemic Control in Youth with Type 2 Diabetes**
- **Compared Treatment of Youth with :**
 - A) Metformin
 - B) Metformin + Lifestyle changes
 - C) Metformin + Rosiglitazone
- **Failure rate declined 13.1% with addition of rosiglitazone**

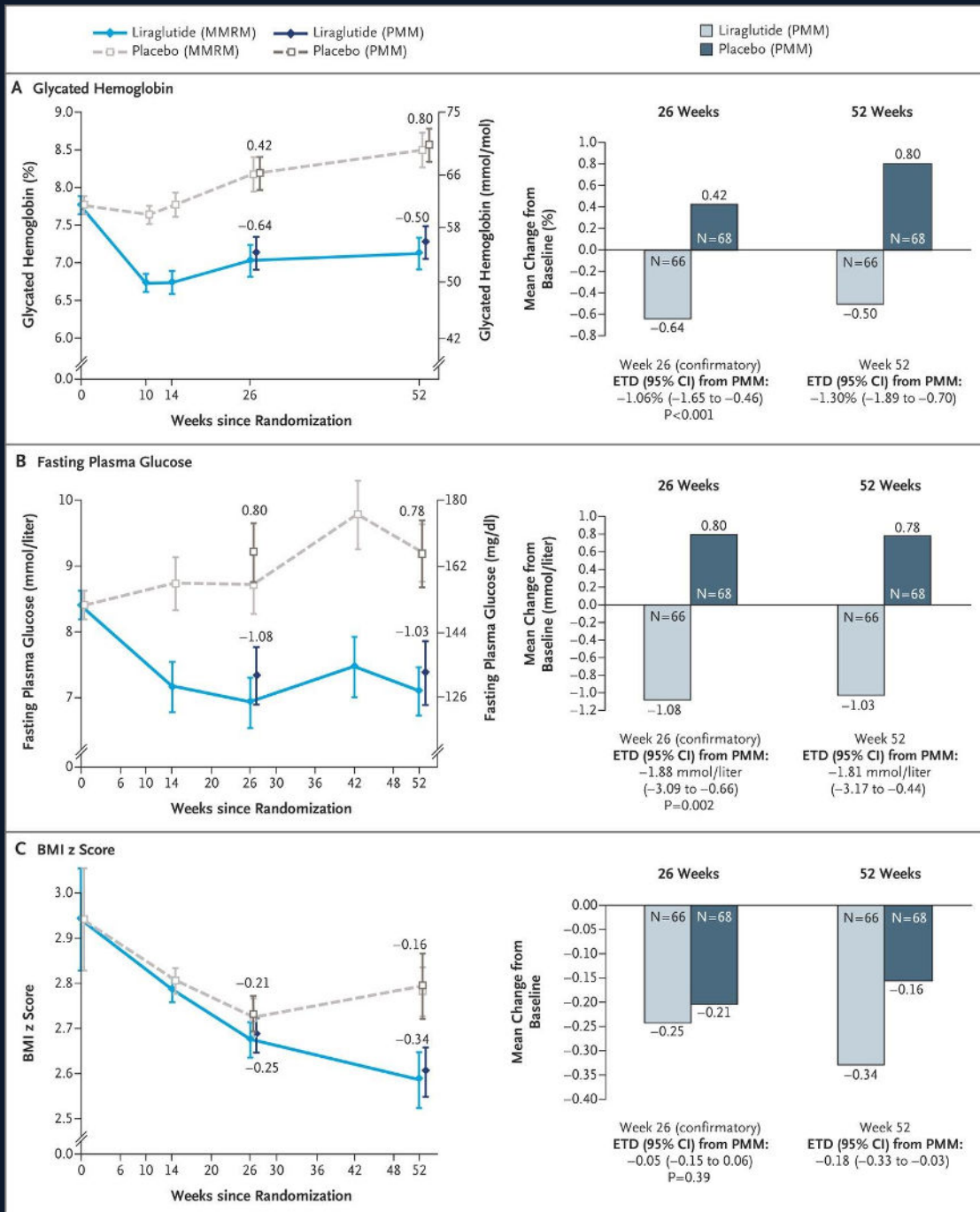
TODAY study results



Zeitler P, Hirst K, Pyle L, et al; TODAY Study Group. A Clinical Trial to Maintain Glycemic Control in Youth with Type 2 Diabetes. N Engl J Med. 2012; 366(24):2247-2256.

Change from Baseline during the 52-Week Trial Period in the Primary and Two Secondary End Points

Tamborlane WV, et al. Ellipse Trial Investigators. Liraglutide in Children and Adolescents with Type 2 Diabetes. N Engl J Med. 2019 Aug 15;381(7):637-646

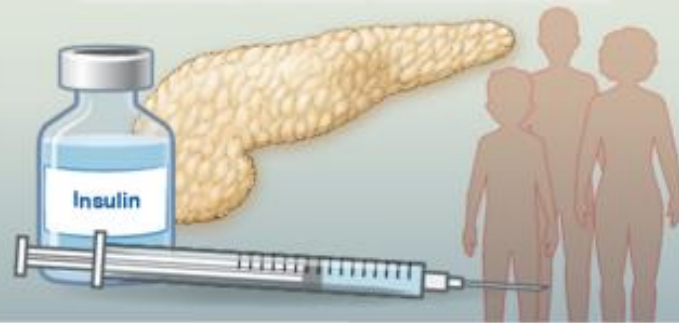


Tamborlane WV et al. N Engl J Med 2019;381:637-646

Liraglutide in Children with Type 2 Diabetes

MULTICENTER, RANDOMIZED TRIAL

134 Children and adolescents receiving metformin with or without insulin



**Liraglutide
+
Metformin**



(N=66)

**Placebo
+
Metformin**



(N=68)

Change in glycated hemoglobin at 26 wk

-0.64
percentage points

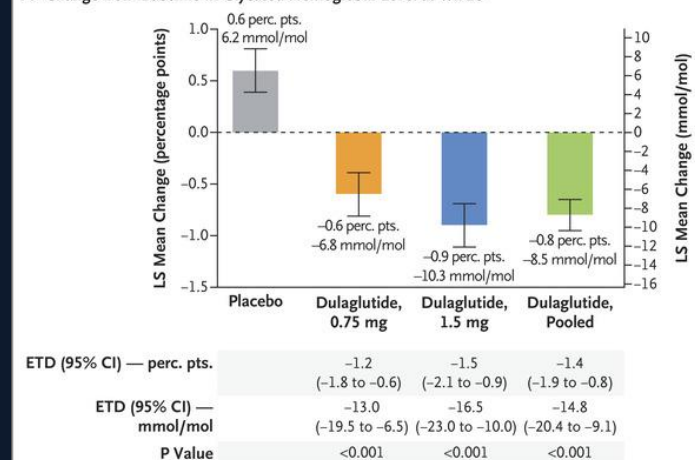
0.42
percentage points

(Treatment difference, -1.06;
95% CI, -1.65 to -0.46; P<0.001)

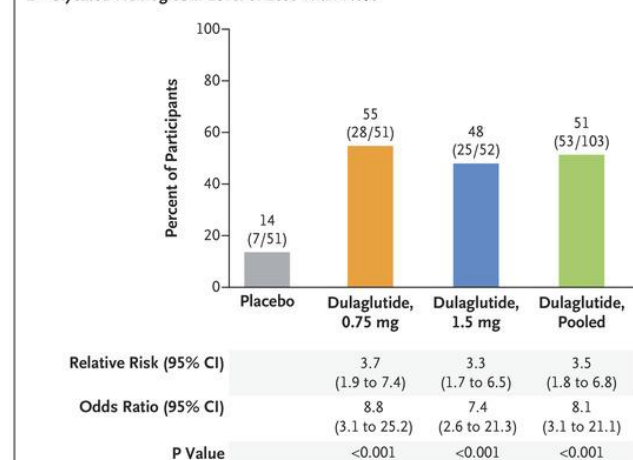
Liraglutide added to metformin with or without insulin improved glycemic control

Change in the Glycated Hemoglobin Level, a Glycated AWARD-PEDS Trial- Hemoglobin Level of Less Than 7.0%, and Changes in the Fasting Blood Glucose Concentration and Body-Mass Index (BMI) at Week 26.

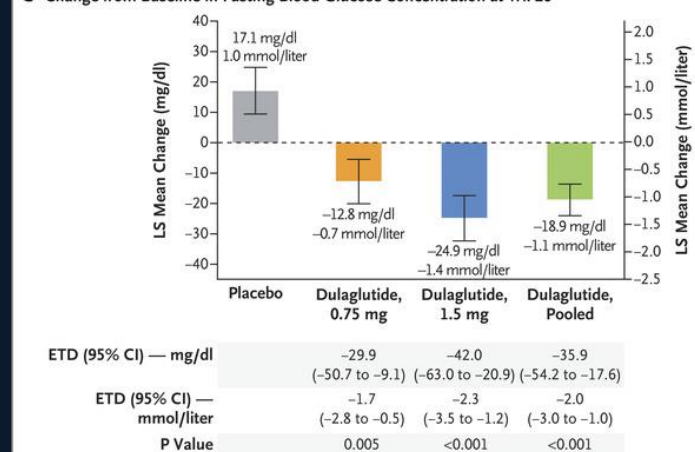
A Change from Baseline in Glycated Hemoglobin Level at Wk 26



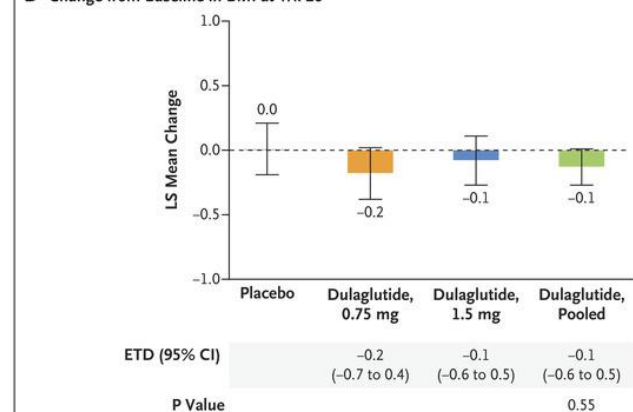
B Glycated Hemoglobin Level of Less Than 7.0%



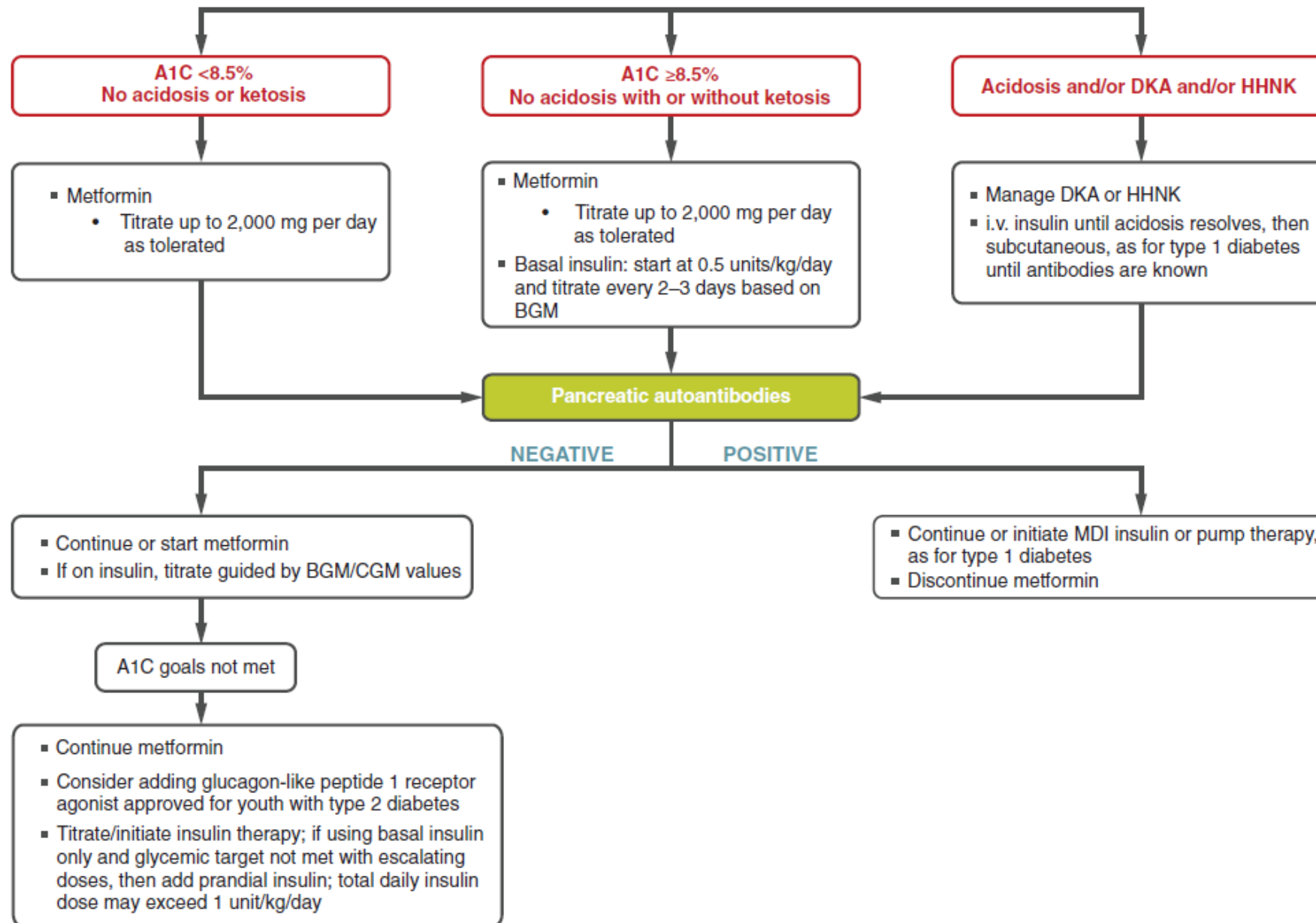
C Change from Baseline in Fasting Blood Glucose Concentration at Wk 26



D Change from Baseline in BMI at Wk 26



New-Onset Diabetes in Youth With Overweight or Obesity With Clinical Suspicion of Type 2 Diabetes
Initiate lifestyle management and diabetes education



**Figure 14.1—
Management of new-onset diabetes in youth with overweight or obesity.**

Children & Adolescents:
Standards of Medical Care in Diabetes - 2022.
Diabetes Care 2022;45(Suppl. 1)

Management—Metabolic Surgery (Type 2)

- 14.75 Metabolic surgery may be considered for the treatment of adolescents with type 2 diabetes who have severe obesity (BMI >35 kg/m²) and who have uncontrolled glycemia and/or serious comorbidities despite lifestyle and pharmacologic intervention. A
- 14.76 Metabolic surgery should be performed only by an experienced surgeon working as part of a well-organized and engaged multidisciplinary team including a surgeon, endocrinologist, dietitian nutritionist, behavioral health specialist, and nurse. A

Other important issues in Peds T2DM

- Mood disorders (Depression, Anxiety)
- Disordered Eating
- Challenges for the Emerging Adult (leaving home, independence, sex, drugs, responsibility, relationships)
- Need a transition team
 - Helps to provide goals for independence
 - Introduce child to new provider
 - Helps to support in gaps of care
 - College
 - Job
 - Lack of insurance/underinsurance
 - Rebel years
- The Primary Care Pediatrician can be a VERY valuable resource for these kids-

Importance of Family-Centered Care

- Addressing cultural issues within family
- Peer-enhanced activities
- Engaging the family helps in younger ages:
 - Adherence to meds
 - Lifestyle changes
 - Provides support system

Summary

- Type 2 DM in children is on the rise
- Type 2 diabetes is MORE progressive and harder to treat in children
- Treat diabetes like you would treat cancer
 - Use treatments as early as possible
 - Use a comprehensive team-based approach



Questions?

Websites:

tu.edu/mobec

diabetesprevention.tu.edu

Social Media:

Facebook: [@DiabetesDREAMTeam](https://www.facebook.com/DiabetesDREAMTeam)

Twitter: [@DiabetesTUCa](https://twitter.com/DiabetesTUCa)

Instagram: [Diabetestuca](https://www.instagram.com/Diabetestuca)



MOBEC programs

Raising awareness about
diabetes and prediabetes



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Free Health
Screenings

Exámenes de
Salud Gratuitos

Libreng Pagpatingin
sa Kalusugan

Campo de Girasoles

Field of Sunflowers

PICTURE BOOK

Por/by:
Dr. Joshua Lawrence Patel Deutsch

Ilustraciones por/illustrations by:
StallionStudios88

CÓMO LA TÍA GUADALUPE

VENCIÓ A LA DIABETES

Por el Dr. Joshua Lawrence Patel Deutsch
Ilustraciones por: Afzal Khan

HOW TÍA GUADALUPE

BEAT DIABETES

Author: Dr. Joshua Lawrence Patel Deutsch
Illustrator: Afzal Khan

PARTS OF THE BODY

By Dr. Joshua Lawrence Patel Deutsch
Illustrated by Jess Marie Soriano

Las Partes del Cuerpo

Por el Dr. Joshua Lawrence Patel Deutsch
Ilustraciones por Jess Marie Soriano

Contando Counting

Por/by: Dr. Joshua Lawrence Patel Deutsch
Ilustraciones por/illustrations by: Afzal Khan

A Maya le encantan los frijoles Maya Loves Beans

Por/by: Dr. Joshua Lawrence Patel Deutsch
Ilustraciones por/illustrations by: Afzal Khan

Almuerzo Lunch

PICTURE BOOK

Por/By: Dr. Joshua Lawrence Patel Deutsch

JUGUEMOS PLAY

por/by:
Dr. Joshua Lawrence Patel Deutsch

Ilustraciones por/illustrations by:
Afzal Khan

PICTURE BOOK

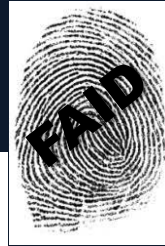
Animal Alphabet Alliterations

Author: Dr. Joshua Lawrence Patel Deutsch
Illustrator: Afzal Khan

Fingerprint Asymmetry as Indicator for Diabetes



Fingerprint Asymmetry Discriminates between Individuals with and without Diabetes



Original Article

A New Method to Assess Asymmetry in Fingerprints Could Be Used as an Early Indicator of Type 2 Diabetes Mellitus

Journal of Diabetes Science and Technology
1–8

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DOI: 10.1177/1932296816629984

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Molly R. Morris, PhD¹, Bjoern Ch. Ludwar, PhD², Evan Swingle¹,
Mahelet N. Mamo², and Jay H. Shubrook, DO³

*Permanence of fingerprints allows for assessment in
cross-sectional study*

Discriminative Accuracy for T2DM: AUC = 0.73

Discriminative Accuracy for T1DM: AUC = 0.85

Recommendations from ADA and AAP

- Youth-onset type 2 diabetes consensus report: Current Status, Challenges and Priorities. *Diabetes Care* 2016.39(9):1635-1642.
- Evaluation and Management of Youth-Onset Type 2 Diabetes: A Position Statement by the American Diabetes Association. *Diabetes Care* 2018 Dec;41(12):2648-2668. doi: 10.2337/dci18-0052. PMID: 30425094; PMCID: PMC7732108.
- Springer SC et al Technical report. Management of type 2 diabetes mellitus in children and adolescents. *Pediatrics*. 2013 Feb;131(2):e648-64. doi: 10.1542/peds.2012-3496. Epub 2013 Jan 28. Erratum in: *Pediatrics*. 2013 May;131(5):1014. PMID: 23359584.
- Copeland KC et al. Clinical Practice Guidelines. Management of Newly Diagnosed T2DM in children and adolescents. *Pediatrics* 2013. 131(2):364-382.
- Diabetes Care for Emerging Adults: Recommendations for Transition From Pediatric to Adult Diabetes Care Systems. *Diabetes Care* 2011. *Diabetes Care* 2011. 34(11): 2477-2485.

Landmark Articles

- SEARCH-Mayer-Davis EJ, et al. SEARCH for Diabetes in Youth Study. Incidence Trends of Type 1 and Type 2 Diabetes Among Youths, 2002-2012. *N Eng J Med* 2017;376:1419-1429. PMID: 28402773.
- TODAY-Zeitler P, Hirst K, Pyle L, et al; TODAY Study Group. A Clinical Trial to Maintain Glycemic Control in Youth with Type 2 Diabetes. *N Engl J Med*. 2012; 366(24):2247-2256.
- RISE Consortium: Impact of insulin and metformin versus metformin alone on beta cell function in youth with impaired glucose tolerance or recently diagnosed type 2 diabetes. *Diabetes Care* 2018;41:1717-1725.

New Reference

- Molinari, Antonia M. and Shubbrook, Jay H. "Treatment options and current guidelines of care for pediatric type 2 diabetes patients: a narrative review" *Journal of Osteopathic Medicine*, vol. 121, no. 4, 2021, pp. 431-440. <https://doi.org/10.1515/jom-2020-0172>.

Pharmacotherapy References

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- Tamborlane WV, et al. Ellipse Trial Investigators. Liraglutide in Children and Adolescents with Type 2 Diabetes. *N Engl J Med*. 2019 Aug 15;381(7):637-646. doi: 10.1056/NEJMoa1903822. Epub 2019 Apr 28. PMID: 31034184.
- Tamborlane WV, et al; Once-Weekly Exenatide in Youth With Type 2 Diabetes. *Diabetes Care* 2022; dc212275. <https://doi.org/10.2337/dc21-2275>